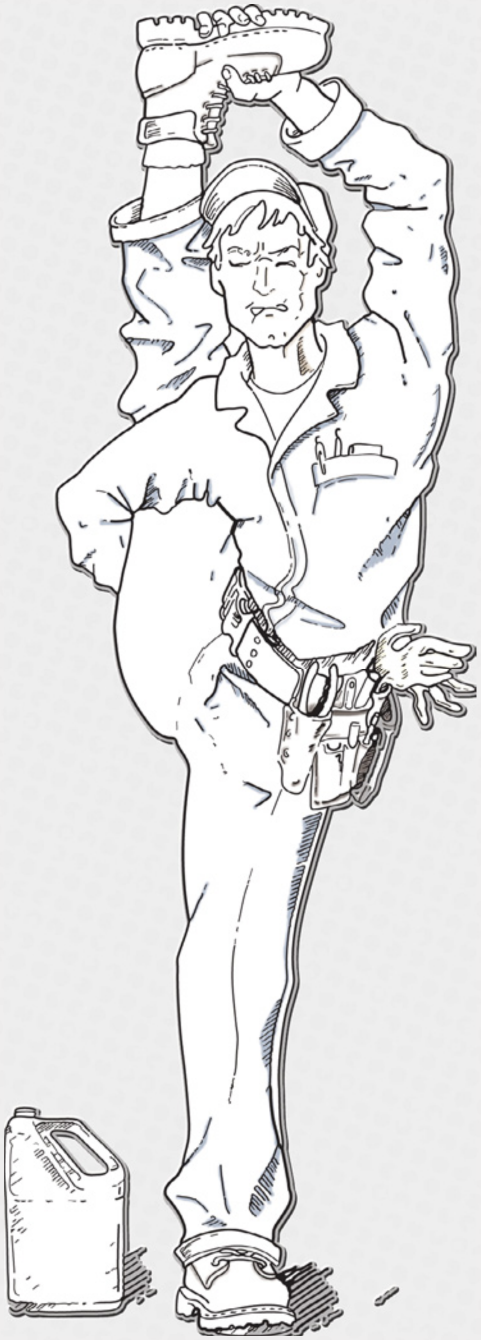


Feeling stretched?

There's a better way.

Des-Case contamination control products help keep your machines up and running – and help you stretch your oil and maintenance dollars without stretching you.

We've spent over 25 years engineering front-line solutions to combat contamination. Our products are designed to be flexible, durable and reliable … combining reliability best practices with easy customization and quick delivery for nearly every application.

uptime®

dec/jan 10

the magazine for maintenance & reliability professio

Sweet Success
at U.S. Sugar

Develop Dependable Data for Your CMMS

Validate Health of Your Reconditioned Motors

Benchmarking Reliability & Maintenance

Solidifying the Structure of Vibrating Screeners

www.uptimemagazine.com


Battery Charger
Power supply
Charging
Danger
Alert
OK
Freq 1000Hz
CH1
CH2
X
ALT
?
commtest
vbSeries

Looking for extraordinary learning, networking and benchmarking?

With the Reliability Performance Institute, it's Reality.

Located minutes from Southwest Florida International Airport (RSW) in tropical Fort Myers, Florida, the Reliability Performance Institute was created to deliver extraordinary learning, networking and benchmarking events designed to create positive change and immediate improvement for the participants. The state-of-art learning center and audio/visual design combined with leading subject matter experts and peer presentations result in high performance strategies, techniques and technologies that can be put to immediate use.

Ultrasound Week
February 9–11, 2010
Fort Myers, Florida

Join us to learn and explore the technology of airborne and structure borne ultrasound as a versatile tool for predictive maintenance, energy conservation and electrical safety and reliability.

http://www.maintenanceconference.com/ultrasound_week.htm

Infrared Week
March 2–4, 2010
Fort Myers, Florida

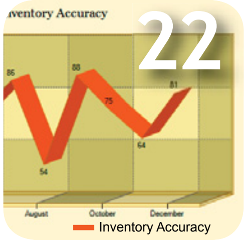
Join us to learn and explore the technology of infrared thermography with a 100% focus on predictive maintenance and reliability applications. This material does not cover home or building inspection. In addition, this event will cover NFPA 70B and NFPA 70E and Arc Flash mitigation.

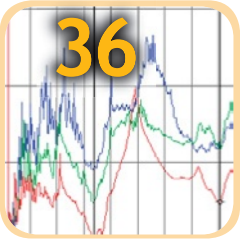
http://www.maintenanceconference.com/infrared_week.htm

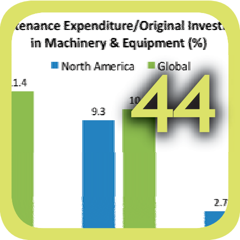
These vendor neutral forums encourage the free exchange of ideas, techniques and technology designed to elevate your Condition Monitoring and Predictive Maintenance program to higher level of performance. Please call one of our conference support specialists toll free (888) 575-1245 or find the latest program details and convenient 24/7 online registration at www.maintenanceconference.com. Seating is limited, so please reserve early to ensure your place.

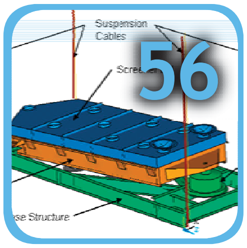
RELIABILITY®
performance institute

8991 Daniels Center Drive, Suite 101, Fort Myers, FL 33912
Toll Free: 888-575-1245 Telephone: 239-333-2500 Fax: 309-423-7234









6 **upfront**

8 **upclose** refining processes provides sweet returns

upload

22 information technology **good data leads to good results**

26 infrared **the NFPA's increasing influence**

32 maintenance management **choosing the right partner**

36 motor testing **finding problems in reconditioned units**

40 precision maintenance **the art of the short repair**

44 reliability **benchmarks provide insight**

50 ultrasound **getting deeper into corona**

56 vibration **quieting vibrating screeners in a petrochem plant**

60 **upgrade** is remote vibration analysis right for you?

Transformation

Transformation doesn't just happen...it is consciously created.

As you will read in this issue's feature story, U.S. Sugar, specifically upper management at U.S. Sugar, actively and firmly made the decision to transform. And that they did.

Through a multifaceted approach, they actively engaged their employees in many decisions along the way. One of their first steps was to instill something that had been missing for quite some time, pride in the workplace. Once that was established, many other hurdles seemed much easier to jump. U.S. Sugar is a success story of an organization that transformed itself from a facility in disrepair and disarray to what is now the leading producer of sugar in the U.S.

I hope that the professionals who attended the Solutions 2.0 conference in Daytona Beach, FL last month were transformed as well. They certainly had the opportunity, if they chose to do so. There was just something a little different about this conference, call it an energy of community. It felt like a group of people coming together not only to learn, but to share their experiences in order to help each other on the journey to reliability. The opportunities to learn, and so transform, were abundant. Whether it was in the presentations, in the expo hall, at lunch or just relaxing in between sessions, there were plenty of occasions to listen, share and learn. Like the space shuttle Atlantis that we saw blast off while we were there, I sincerely hope that Solutions 2.0 can be used as a launching pad for maintenance programs to accelerate their progress.

Our 2009 Uptime Magazine PdM Program of the Year Award winners also made the decision to transform. The professionals that run these winning programs were recognized at an awards ceremony at Solutions 2.0. As diverse as the programs were, and with each excelling in different areas, it was obvious that all the programs had some things in common. Commitment, teamwork and perseverance were all common threads that wove through this community of winners, but most of all, they seemed to embrace a clear vision of where they want their programs to be. I would like to personally congratulate each program again for their success, and we look forward to following their continued accomplishments.

I hope you enjoy this issue. As always, thank you for reading. We appreciate your support, and hope you find value within these pages, the digital issue and on our website. If you have any questions, comments or suggestions that will make Uptime more useful to you, please let us know.

All the best,

Jeff Shuler
Editor In Chief
jshuler@uptimemagazine.com

uptime®
volume 5, issue 38

ADVERTISING SALES
Bill Partipilo
888-575-1245 x 114
sales@uptimemagazine.com

EDITORIAL INFORMATION
Please address submissions of case studies, procedures, practical tips and other correspondence to

Jeff Shuler, Editor In Chief
Uptime Magazine
PO Box 60075
Ft. Myers, FL 33906
888-575-1245 x 116
jshuler@uptimemagazine.com

SUBSCRIPTIONS
to subscribe to Uptime, log on

www.uptimemagazine.com

Uptime Magazine is a founding member of

AMP
the association for maintenance professionals

Uptime® (ISSN 1557-0193) is published bimonthly by Reliabilityweb.com, PO Box 60075, Ft. Myers, FL 33906, 888-575-1245.

POSTMASTER: Send address changes to: Uptime Magazine PO Box 60075, Ft. Myers, FL 33906.


Embracing the Future Together . . .

ReShaping Sugar

A 12% increase in production capacity over three years with virtually no increase in operating costs makes United States Sugar Corporation the leading producer of retail and industrial bulk sugar in the United States.

by Darrin Wikoff, CMRP

United States Sugar Corporation is headquartered in Clewiston, Florida. Clewiston is a remote agricultural town of about 7,000 people located near the southern shores of beautiful Lake Okeechobee and is affectionately referred to as "America's Sweetest Town." Nestled amongst the Florida Everglades and the rich soils of sugar cane fields is the world's largest fully-integrated sugar factory and refinery, originally referred to by founder Charles Stewart Mott as the Clewiston Sugar House. Perched upon roughly 200 acres of land, the facility is supported by 405 employees. Today, thanks to improvements made via technology, the "Breakthrough Project", and a program known as "Operational Excellence", the refinery produces over 700,000 tons of sugar per year from its nearly 188,000 acres of sugar cane crop.

In 2006, the Clewiston Sugar House embarked on a journey to become the lowest cost producer of sugar in the world. As a result of competitive pressures stemming from Mexican imports and other offshore refineries, a 400% increase in fertilizer cost, and rising fuel costs, President and CEO, Robert 'Bob' Buker Jr. targeted the Clewiston facility to increase capacity and reduce operating costs. His message to the newly appointed Vice President of Manufacturing, Neil Smith, was simple: "change the culture." With plans for expansion already underway, Smith acknowledged, "I needed reliability to make a difference in how we were to do business." He needed to develop a strategy that would deliver lower operating costs and ensure quick recognition of their 950 tons per hour, technology-driven expansion and create a sustainable culture of process efficiency. In February 2007, U.S. Sugar began revitalizing their agribusiness in Clewiston through a dedicated focus on building systems – infrastructures and business processes – to ensure higher levels of operating performance. Everything about how U.S. Sugar managed the Clewiston Sugar House was about to change, and with dramatic results.

In 2007, the Clewiston facility was in a state of disrepair. Many of the assets used in sugar milling and refining were badly deteriorated and covered in process remnants and mounds of bagasse – the by-product of sugar cane milling which resembles grass clippings. Debris, scrap from past expansion projects and discarded equipment were strewn throughout the facility. Smith and the Engineering & Maintenance Manager, Derek du Plooy, saw this as an opportunity to quickly illustrate how Clewiston could reform their culture by bringing pride back into the workplace. They began engaging employees in cleanup efforts, allocated resources to removing scrap yards and obsolete materials, and planted grass, trees and other shrubbery and flowers where debris had once been.

In addition to housekeeping efforts, Management aggressively identified, and implemented, several quality-of-life campaigns geared towards improving employee workspaces and break areas. For example, for the first time in decades, mechanics in the Boiling, Evaporation and Crystalization areas now have an adequate workshop to complete major equipment repairs and store their tools. With many of the employees at the Clewiston facility having more than 20 years of dedicated service to U.S. Sugar, and a notable level of distrust resulting from past management practices and breakdowns in Union relations, culture change was not going to be easy. Through these efforts and others focused on engaging employees in decisions affecting the improvement process, Management was confident that change was possible.

Before beginning the Operational Excellence journey, Clewiston was accustomed to losses that impacted "pan strikes" – a term that refers to an old practice of striking a keyway which allowed the sugar batch to flow into the refining process – to the tune of $5.4M per month, or just over 237,000 cwt (hundred weights) of lost production. Downtime was no stranger to this facility, and it affected assets of all types – mills, motors, boilers and even railcars. This is significant because the business of making sugar from sugar canes is constrained by the seasons.

U.S. Sugar, like many other sugar factories, has a harvest and sucrose extraction season that lasts between six and eight months. From October through April, sugar canes are ideal for harvest, and the factory must maximize process flow to ensure continuous shipments of refined sugar to customers throughout the year. The optimum lead time from harvest to grinding the sugar cane is only seven hours, so every minute counts when transporting the cut canes from the field to the factory. Delays during harvest may also jeopardize the organization's ability to supply steam and electricity to the factory, because the power house, which allows the Clewiston facility to be self-sustaining and therefore, minimize utility costs, burns bagasse as their primary fuel source. In response to these challenges, U.S. Sugar and Management at the Clewiston Sugar House decided to pursue a global Operational Excellence effort that would bring improvements to both the agriculture and refining business units.

Figure 1 - Scrap from past projects next to Mill.

Figure 2 - Beautification efforts outside raw sugar warehouses.

Operational Excellence

The Operational Excellence mission of U.S. Sugar is clearly focused on bringing pride back into the workplace in order to be the low cost producer within the United States.

"The way you change culture is to instill pride," says Neil Smith. Upon Smith's desk lies a stack of laminated pocket cards entitled "The Change" which illustrate the mission of Operational Excellence. Smith uses these cards when employees enter his office as a means of continually reinforcing the company's desire to create a more inviting workplace that enables efficiency and improvement. Even after two years of implementation, Smith and his leadership team are committed to culture change as the leading improvement objective. To say that change is part of the improvement strategy would be misleading, it's the overall mission of Operational Excellence. Everyone within the Clewiston facility has a responsibility to instill pride. Everyone from the Maintenance and Engineering staff to the administrative staff has been recruited to assist with the transformation. As an example of inclusive thinking, administrative assistants are responsible for monitoring and managing landscaping maintenance and restoration. No one takes this mission lightly, and that's an indication of the level of pride that Management has already instilled.

The mission of Operational Excellence continues with a focus on processes, or systems, as Smith and his team commonly call them. These systems are the means by which business leaders hope to institutionalize new behaviors in support of reliability, maintenance, materials management and operating best practices. "Operational Excellence put in systems and steps that allow the culture to evolve," says Jack Webb, the Powerhouse Maintenance Planner. Evolution of culture, instead of forcing people to change their behaviors, is a very unique approach to change management – one that, if you stop and think about it, makes sense. Like many other competitive companies, U.S. Sugar has undergone numerous improvement initiatives in the past which claimed to have a culture change component. In the past, they've focused on "managing" the change, meaning they used tactics aimed at requiring people to adopt changes. In the past, resistance to changes merely shifted from active to passive, leaving Management with a perception of success. When the focus moved to the next "flavor of the month" employees went back to doing things the same old way, producing the same old results. The approach to Operational Excellence is different because the primary focus is on culture change, therefore requiring solutions that would deliver change.

In February 2007, Smith engaged Life Cycle Engineering (LCE), a Charleston, SC-based reliability consulting firm, to guide and mentor U.S. Sugar through their journey towards Operational Excellence. Leveraging LCE's Reliability Excellence methodology, from March to May 2007, the Clewiston Sugar House partnered with industry experts and representatives from the agricultural business to develop formal business processes. The system design focused on four main areas of Operational Excellence:

Work Management – Those processes which govern how U.S. Sugar would manage maintenance resources and coordinate activities with operations in order to more efficiently execute repairs and preventive maintenance routines.

Materials Management – Those processes which would ultimately enable U.S. Sugar to consolidate inventory warehouses and optimize on-hand quantities to reduce holding costs while ensuring a just-in-time delivery of materials to operations and maintenance.

Reliability Engineering – The focus within these business processes was failure prevention and asset care. Redefining how U.S. Sugar develops and executes preventive maintenance programs, or how they capture and analyze failure data, has added a level of predictable performance that's been lacking since the first pound of sugar cane was ground in 1929.

"In meetings now we talk about the consistency of Milling operations (from hour to hour) instead of focusing on overall tons per day," says Sean Miller, Reliability Engineer.

Operational Efficiency – Operations focused on developing systems to 1) identify the source of losses which impact sugar production; 2) report losses on an hourly basis to determine corrective actions; and 3) quantify the impact of the cumulative losses. As a philosophy, Overall Equipment Effectiveness (OEE) was the model that led to the current methodology in place. However, unlike most OEE first-timers, the Clewiston leadership team focused on eliminating repetitive losses per day instead of focusing on the number or percentage of OEE. This leading-indicator application of OEE has helped to change the culture within the operating ranks.

The Reliability Excellence Model, shown in Figure 3, outlines the areas of improvement that helped U.S. Sugar drive culture change within the Clewiston facility. Beginning with a solid foundation of management commitment, strengthened by cross-functional partnerships between Maintenance Planning, Engineering and Maintenance Supervision, the facility was able to engage employees in defining the problem statement and gaps which were preventing the Sugar House from achieving the desired levels of operational efficiency. Through a business process re-engineering approach, focus teams were able to define the systems needed to transform their business. These focus teams included members from all levels of the organization, from the Refinery, Factory, Powerhouse and Agriculture. Although the teams were facilitated by LCE coaches, it was U.S. Sugar employees, the stockholders, who ultimately deployed solutions within every aspect of the operation which delivered results and seeded the culture change initiative.

The initial implementation of newly designed business processes began in June of 2007. The implementation began in the boiling operation, where sucrose extracted from the sugar cane enters a series of centrifuges and boilers in order to separate the raw sugar crystal from the molasses, then quickly spread to the Powerhouse, Factory and finally the Refinery itself. Throughout the implementation in 2007 and 2008, employees and management worked to refine the systems put in place as their understanding matured and results were recognized. Since 2007, the processes have been simplified, no longer needing the original degree of detail, and today serve as a method of auditing one another, as partners, against agreed upon standards of practice. For example, during the 2009 summer repair – a planned outage within the factory that allows the organization to recondition assets in preparation for the grueling harvest season – management revoked overtime as a means of completing the planned work. Instead, management and supervision within maintenance and operations held each other accountable to follow the business processes and work within the framework of the system. This was a real proving ground for Operational Excel-

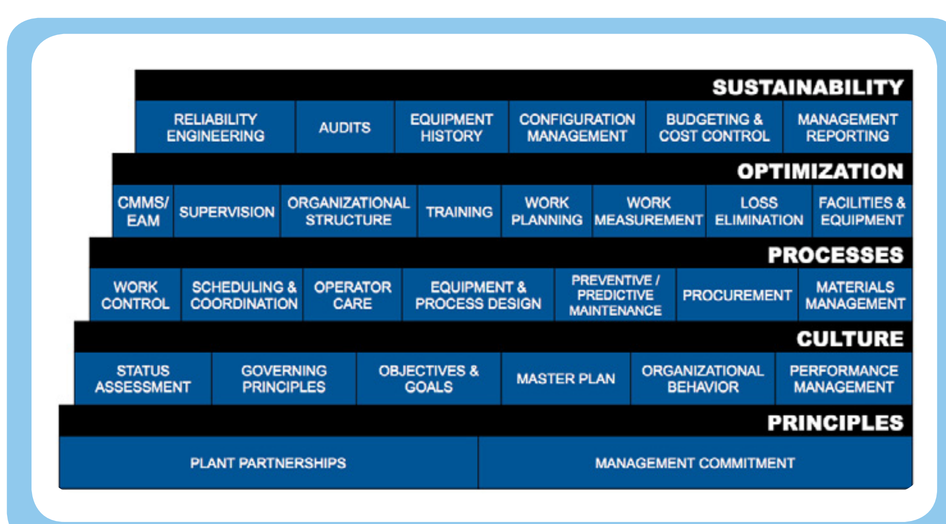


Figure 3 - Reliability Excellence Model

lence. By mid-September, two weeks before the outage period was scheduled to conclude, 99% of the scheduled work was completed as planned, and no additional overtime, beyond scheduled overtime resulting from natural shift rotations, was necessary. The system worked! Everyone from the controller to factory operators were impressed with the results; never before had a summer repair gone so smoothly. Just one year prior, maintenance had expensed a considerable amount of overtime in an effort to rush the scheduled work to completion within the last 2-3 weeks of the outage.

Today, efforts continue in materials management, job planning and the development of preventive and predictive maintenance routines. There's a new level of confidence in the system that's helping to accelerate improvements in these areas. A heightened level of trust within the materials management system has created an increase in demand for kitted materials – prepared packages of spares, consumable materials and special tools for repairs and preventive maintenance. Operators are being engaged more and more in preventive maintenance routines throughout the factory, performing duties such as cleaning, lubrication and recording system parameters for engineering analysis. Reliability engineering resources are continuing to help minimize downtime through the application of predictive technologies like vibration analysis, oil analysis and thermography. The level of skepticism is diminishing. One Operations Supervisor, Billy Dyess, shared "I wasn't a believer in vibration analysis…I didn't have time to stop packaging." Dyess explained that his perception of the value that predictive technologies can bring to his organization has changed: "The first couple of 'predicted failures' made me a believer."

The Clewiston Sugar House is not out of the weeds yet; there's still a long road ahead. Failures still plague the factory and other areas of the facility, but operations continues to monitor losses and the number of days of good production without a failure, in order to help maintenance and engineering improve the system. More and more data is being compiled within the newly implemented SAP enterprise asset management system that engineering will be able to use to further eliminate those repetitive problems that are still preventing the operation from reaching the new performance targets established by upper management. Maintenance is working to continually strengthen their ability to reduce turnaround times when critical equipment repairs are necessary. The collaborative efforts of these partners will continue the focus on culture change, and within a couple of years you'll be reading about U.S. Sugar achieving Operational Excellence.

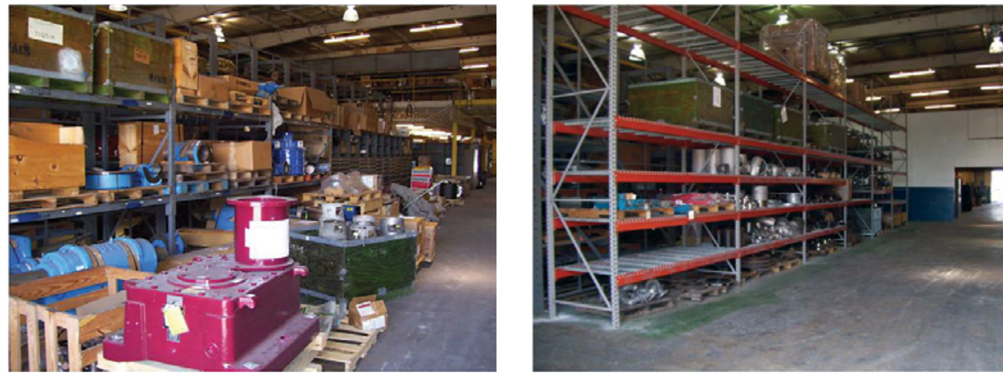


Figure 4 - Photos of MRO material storage in Central warehouse before the project and properly stored materials after the project implementation.

Operational Excellence Delivers Results

If you participated in the U.S. Sugar tour at the International Maintenance Conference (IMC) in December of 2008, then you were able to see firsthand the improvements that were being made at the Clewiston factory. But, I'll bet you didn't know of their success. Operational Excellence has already delivered some pretty amazing results for the Clewiston Sugar House. Although pan strike losses and energy losses still occur, there's been significant progress towards reducing operating costs per unit of production. Here are some of the measurable results from U.S. Sugar's journey to Operational Excellence:

- Within two years, grinding operations in the factory have increased 16% from 27,000 tons per day to over 32,000 tons. In fact, in the first 19 days of the 2009-2010 harvest, the Factory set a record production of 500,000 tons of processed sugar cane, which equates to 92,000 tons over projections and nearly three days of additional sugar processing capacity. Much of these gains can be attributed to more effective maintenance being performed during the off season, as evident by a 35% decrease in "emergency work."

- In turn, the refinery has had record production runs for the past two years with an overall increase in production capacity of

Figure 5 - Aerial plant photo after cleanup efforts.

just over 12%. The additional sales of 1.7M cwt is a direct result of those efforts focused on the elimination of failures, more efficient execution of maintenance during service-days and mini-outages, and operators taking ownership for the day-to-day condition and care of their assets. Mechanics and operators working together reduced elevator failures from one per month in 2007 to a total of two in 2009, an 83% reduction in downtime.

- Operational Excellence has also significantly impacted maintenance costs. For example, during the last repair season, contract labor costs were reduced by 33% as a result of increasing internal labor utilization by 12.4 FTE's throughout the entire factory – both a direct result of improvements made in work and materials management.

- The materials management focus quickly resulted in the elimination or sale of $2.9M of obsolete or damaged inventories that were continuing to accrue carrying costs. Indirectly, by removing the poor quality maintenance spares, down time to operations has been reduced, resulting in the already mentioned improvements in capacity. Most notably, Clewiston has consolidated inventories from the refinery and agriculture, reduced the number of warehouses being occupied and maintained by the facility from 11 to 3, and reduced warehousing labor by 8 FTE's.

- We can't forget the customer focus of Operational Excellence. As of October 2009, customer complaints, at 0.05 per 1000cwt, are down 84% from 2006, and 54% from 2008, an impressive testament to the overall impact that culture change can have on an organization's ability to increase customer value.

So, what about the culture change? Are we there yet? The Warehouse Manager, Randy Hall, had this to say, "There are holes in the wall now; before it was a solid brick wall." Pride is evident in every aspect of the U.S. Sugar operation in Clewiston. Leadership continues to reinforce the expectation that employees need to take ownership of their facility and the work they do day-to-day. Business systems that were in place prior to the implementation of Operational Excellence are constantly being challenged to ensure that they meet the overall mission of the facility. Darrel Collier, the Factory Manager, said "The first year was pretty tough…but once we understood the system, it got easier and easier." Culture change is not a quick win in any improvement strategy. Change takes time, but this facility, and leadership, is willing and committed to making it happen. As a consultant with more than eight years of experience helping organizations like U.S. Sugar implement transformational change, I can't remember when I saw so much dedication to change. I believe that their success, and what holds leadership accountable for the change, is the routinely communicated mission of Operational Excellence, "The Change." Organizations that declare victory once they see evidence of the solution driving the desired result ultimately fail to recognize the full potential of Operational Excellence. In my mind, this factory is different. Leadership in Clewiston won't sound the trumpets of victory until they see evidence of a new, institutionalized culture. This implementation has not been a technical solution with a cultural component; it's a cultural solution with technical enablers.

Sustaining the Gains

Sustaining the Operational Excellence journey requires you to first align your organization based on the long-term vision of how your organization is to do business. As Neil Smith expresses it, "If we're not going to be reactive, then we don't need the redundancy in management to support the reactive." This refers to Smith's focus on aligning his leadership and supervisory structure within the factory to support a proactive and more efficient manufacturing operation. Consolidating supervisory positions that were in place due to former reactionary habits afforded Clewiston the opportunity to reallocate qualified resources to new roles such as Maintenance Planner, Material Coordinator and Reliability Engineer. These roles help support the implementation and long-term sustainability of newly defined business processes.

Most people within the factory believe that they are achieving a level of stability that affords them the opportunity to really optimize performance of the operation. The organization is now in a transition from a maintenance-led, although manufacturing sponsored, improvement campaign to one that's led by operations. Supervisors aid the sustainability efforts by frequently communicating how the system is designed to work and how it will affect operators, in order to further build awareness. Employees within operations have not been as engaged as the maintenance and engineering departments, beyond the housekeeping efforts originally deployed by Smith and his leadership team, so sustainability means getting these people involved in decisions affecting improvements in their areas. There are a number of pockets of excellence where operators are taking a more aggressive role in operational efficiency. For example, in the refinery, operators in the packaging area are competing with one another to see who can maximize production while working within the guidelines of the system. It's this type of healthy focus on efficiency that will enable the Sugar House to sustain improvements over the next couple of years.

Management is also working on sustaining the gains. Metrics are now in place that help business leaders monitor the operation against the system. For example, SAP notifications are tracked to ensure operators and operations supervisors are entering maintenance needs in the work order system to be prioritized, planned and scheduled. Supervisors are also tracking the number of notifications that identify a potential failure before it impacts production. These monitoring practices will ensure the integrity of the system while continuing to reinforce cultural expectations. Although some people still operate outside the system, it's getting harder and harder to hide.

While this story has focused on the manufacturing side of the business, the agriculture side of the business has been involved since the global design of the system and has implemented many of the same improvements. Another aspect of sustainability worth noting is the impact of Operational Excellence on the agricultural business. Because of the record production levels achieved during this year's opening harvest, with the factory being three days ahead of projections, agriculture will benefit from operating cost reductions, theoretically having to harvest three days less this year than in previous years. This effectively reduces the demand in agriculture on labor and fuel, resulting in a $2.5M savings. This supply chain effect is a great catalyst for sustainability and the enterprise partners will achieve a lower overall cost per unit and ensure future collaboration with regards to improvements.

An Interview with Robert Buker, Jr., President of U.S. Sugar

Robert Buker, Jr. is a welcoming, gracious and personable man. His pride for U.S. Sugar's accomplishments in Clewiston is abundantly obvious, and he clearly believes that Operational Excellence has averted the closure of the Clewiston Sugar House.

Buker described the Clewiston facility as "out of control on so many levels" prior to the Operational Excellence implementation. "We didn't know what we were making, buying or even paying our employees." Buker explained that U.S. Sugar didn't have the systems in place that allowed them to understand how much sugar they were making, or measure performance of any part of the operation, and they didn't understand how much of an impact the agricultural side of the business was having on manufacturing. With market prices flat since 1980, "we were getting squeezed and had to make a change."

"You don't lay out a battle plan you can't explain in a few words," he said when I asked why his primary expectation of leadership was to change the culture. He went on to say that "if you make it too complicated, people will lose interest." Buker's patience and understanding of the improvement process is unusual for a man of his position. Most executives want improvements immediately, and no doubt he did too, but his fortitude to stay the course and hold his leadership accountable to deliver has been a critical success factor. "If you attack further behind enemy lines, you don't always feel the impact, but a more significant impact you make." This was the analogy he used to explain his decision to go with an improvement strategy like Operational Excellence, which would take three to five years to deliver significant results. I should mention that many of Buker's analogies were military references which stemmed from his upbringing and passion for military history. Buker admitted he was not always patient. He didn't wait for the culture change to be "fully staged", in his words, but instead pressured the organization to implement the breakthrough project and both technical and change-oriented improvements of Operational Excellence at once. If he'd had it to do again, he would have waited.

Buker describes today's Clewiston operation much differently. "We're measuring each stage from cut to deliver to grind to refine". He's proud of the fact that their ability to deliver cut sugar canes to the Factory in seven hours or less is the best in the world, and ultimately helped them avoid nearly $5M in sucrose losses this year, which certainly translated into increased revenues. Buker speaks fondly of the fact that Clewiston is more deliberate in their activities, "more precise in everything we do." Buker summed it all up by saying that the implementation methodology, facilitated by Life Cycle Engineering, was "an ignition source for culture change" and helped the Clewiston Sugar House transform their business from "terrible, to world-norm, (and soon) to world-class."

Learning from the Clewiston Sugar House

What can we learn from U.S. Sugar's journey to Operational Excellence? Here are a number of key observations that you should keep in mind before beginning your improvement process:

1. The mission is culture change, and capital enhancements and technical improvements are best deployed as enablers.
2. Employee engagement is critical to success, it's all about the people and your first step is to instill pride in the workplace.
3. Never overlook the opportunity to communicate the mission of your improvement strategy or the intent of the solution. Building awareness builds desire in your employees to get engaged.
4. Design your "system" with the beginning and end in mind. When beginning your improvement process, employees need more detail to fully understand the system and how they are integrated into the system. Once implemented, refine the system as a method of auditing and maintaining personal accountability to uphold the principles of your strategy.
5. While starting slowly within a specific area of your facility, embrace the eagerness of leaders who take the design to new levels of enthusiasm, commitment and results.
6. Continually reinforce the successes that your improvement process brings to the organization. Once again, never overlook an opportunity to initiate a conversation that reinforces the mission and how the organization is working towards that mission.
7. Keep the focus on the long haul. Put people in positions where they can be successful in executing the new system. Remember that the overall goal is culture change, and position your business leaders where they can effectively sponsor the change.
8. Recognize when certain groups or departments have not been involved as a result of the initial design. Take steps to reshape your strategy in order to increase engagement and further drive performance results.
9. Education is the first, second and third step in your implementation process. Employees who don't understand the system or how they must change their behaviors in order to work within the system will inevitably develop work arounds. Work arounds restrict your organization's ability to achieve the full potential of your solution.
10. Build partnerships within your supply chain in order to share lessons learned and leverage improvements that impact customer value.

Darrin Wikoff, CMRP, specializes in organizational change management, business process re-engineering, reliability engineering, and work management. As a Principal Consultant and adult education facilitator at Life Cycle Engineering (www.LCE.com) Darrin empowers his clients and students with the skills and knowledge necessary to implement business transformation initiatives like Lean Manufacturing, Total Productive Maintenance and Reliability Excellence. Darrin can be reached at dwikoff@LCE.com

Primetime Programs

2009 PdM Program of the Year Award Winners

UPTIME'S PdM PROGRAM OF THE YEAR

Uptime Magazine is proud to feature a special group of people and companies who have risen to the challenges nearly all maintenance program face and have earned the prestigious Uptime PdM Program of the Year Award. This award is designed to acknowledge exceptional predictive maintenance programs and the teams that create them, run them and continuously improve them.

The winners of the 2009 Uptime PdM Program of the Year Awards gathered for the award presentations at the Solutions 2.0 Conference in Daytona Beach from Nov. 16th-19th. We are excited to tell you about each winning program and congratulate them all for their outstanding work in Predictive Maintenance/Condition Based Maintenance.

The 2009 Uptime Magazine PdM Program of the Year Award Winners

We would also like to acknowledge all of the PdM programs that entered this year. The overall quality of the entries continues to make our job of selecting the winners more difficult - but that is a challenge that we couldn't be happier to have, because it is a clear indication that, as an industry, reliability and maintenance is improving. And, now, without further ado, here are this year's PdM Program of the Year winners:

Best Overall PdM Program - Pfizer Global Manufacturing, Kalamazoo

Pfizer is the world's largest research-based biomedical and pharmaceutical company with 89,000 employees in more than 100 countries, including nearly 4,000 in Michigan. Pfizer also ranks number one in sales on the strength of well known products such as Celebrex, Lipitor, Viagra, Xanax, Zoloft and Zyrtec. Pfizer employs about 3,200 people in Kalamazoo County, many of whom work at its large manufacturing plant in Portage -- the company's largest manufacturing plant worldwide (shown below).

Pfizer's PdM team is responsible for more than 10,000 pieces of rotating equipment and over 130,000 total pieces of equipment. That is a sizable amount of responsibility, but they have the expertise to provide an outstanding level of maintenance.

Pfizer Global Manufacturing PdM Team

The Pfizer PdM team is a process driven group. Processes are in place and written into a document that covers all the bases. This is a critical step in a maintenance organization's evolution. A written procedure documenting instructions, and when to perform them, can transform a program from being excellent to being a truly sustainable program.

The Pfizer PdM team has a strong commitment to both training, as evidenced by 15 people holding certifications of some kind, and to Six Sigma (PdM Technician has led and completed at least one Six Sigma Yellow Belt Analysis).

This PdM team has provided excellent results across the spectrum of PdM technologies. Some of their accomplishments include elimination of: premature gear oil replacement, premature bearing failure, premature belt failure, unplanned production downtime and premature failure of motors. This has led to a drastic overall reduction in suspect equipment and in the estimated budget.

Best Emerging PdM Program - San Antonio Water Systems

The San Antonio Water System (SAWS) is a public utility owned by the City of San Antonio. SAWS serves approximately 1 million people in the urbanized part of Bexar County. This population includes approximately 325,944 water customers and 354,878 wastewater customers, and is the only sewage treatment agency in this area.

SAWS is divided into three sections that cover all of San Antonio, TX and some of the surrounding counties. They have 4 waste water treatment plants, 10 Heating and Cooling plants, over 100 lift stations and over 100 potable/recycle water stations.

The PdM team has gone through the Clemson University training for maintenance. The PdM technicians are all vibration level 2 certified, Infrared Certified and Airborne Ultrasound certified. The PdM techs have also been through precision alignment training, offline motor circuit analysis training and online electrical signature analysis training. The team has equipment for every training program they have completed, and these tools are used to find and correct problems.

San Antonio Water Systems PdM Department

While new at it, they have begun using root cause analysis to examine why failures occur. They are now piloting a PM program where PMs are generated based on need instead of being time based. The PdM team has been successful in dramatically reducing premature bearing failure due to both misalignment and water intrusion, and also in reducing equipment shutdowns caused by overheated electrical components.

SAWS built this program from ground zero with very little outside help. They took two of the best electricians and two of the best mechanics in the company and trained them in PdM technologies and methodologies. The planning team took a newly implemented CMMS and created the entire workflow process for the company, creating standardized pm's. They are now well on their way to becoming a condition based maintenance structure.

Best Green PdM Program – Alcoa, Mt. Holly

Situated on 6,500 acres in Berkeley County, SC, Alcoa Mt. Holly produces 235,000 tons of primary aluminum annually. Built in 1977, Mt. Holly is the most advanced plant of its kind in the United States, a pacesetter in production efficiency, energy utilization and environmental protection. It was the first primary aluminum plant in the world to be registered totally to the ISO 9002 Quality System Standard. The products produced at the facility include: Commodity Grade P1020 (Tee/Standard), Foundry Ingot (Tee/Standard), Billet and Rolling Slab.

Mt. Holly is also a member of the S.C. Environmental Excellence Program and was recognized by the SC Department of Commerce in 2008 as the best large industry recycling program in the state.

Alcoa, Mt. Holly Reliability Team

The Ultrasound Program at Mt. Holly has greatly reduced energy consumption. The facility has gone from running seven compressors full time to running five full time, one cycling between loaded and unloaded and one on auto shutdown. Because of this increased efficiency, the facility no longer has to utilize rental compressors in order to do routine maintenance. This, along with other improvements, has led to a savings in electricity of roughly $8000-$9000 per month. As another program positive, interruption to production throughput has also been greatly reduced.

The Ultrasound Program also inspects for corona, arcing and tracking in the high and medium voltage equipment throughout the entire plant, inspects for bearing problems on highly critical equipment and inspects cruces for vacuum leaks.

Best Lubrication/Oil Analysis Program – Calpine Corporation

Calpine Corporation is helping meet the needs of an economy that demands more and cleaner sources of electricity. Founded in 1984, Calpine is a major U.S. power company, operating nearly 90 facilities and capable of delivering nearly 24,500 megawatts of clean, cost-effective, reliable and fuel-efficient electricity to customers in Canada and 16 states in the U.S. The company owns, leases and operates low-carbon, natural gas-fired and renewable geothermal power plants.

Capline PdM Team

The PdM program is functional at all Calpine plants which approximates to 25,000 MW of generation capacity and generated 89 Million MW hours of power in 2008. The multi-faceted PdM approach includes the application of vibration analysis, airborne ultrasonic detection, on-line motor analysis, off-line motor analysis, infrared thermography, lubrication oil analysis, transformer oil analysis, corona surveys, and ultrasonic pipe thickness testing.

One of the more impressive problems identified by Calpine's PdM program was combustion turbine lubrication and control oil varnish deposition, which was resulting in failed starts and unit trips (at a cost of $15,000 per occurrence). The solution involved multiple mitigation techniques and system changes, including an ion charged bonding system and installing anti-static filters.

The reduction of unnecessary PM's, optimization of existing PM's and addition of relevant PdM activities is actively pursued on an ongoing basis. Calpine's transformer and lubrication oil programs utilize the internet to access the data (database downloads are performed periodically and the data stored on servers internal to Calpine).

According to Calpine's numbers, since its inception, their PdM program has produced a return on investment of over 500%.

Best Precision Maintenance Program - NASA Kennedy Space Center & ISC Predictive Technology Group

Located on Florida's Space Coast, NASA's John F. Kennedy Space Center (KSC) has helped set the stage for America's adventure in space for more than four decades. From Mercury through Gemini and Apollo to the space shuttle and International Space Station, the spaceport has served as the departure gate for every American manned mission and hundreds of advanced scientific spacecraft. It contains 489 buildings (comprising 7,345,579 ft^2) and 291 other structures. KSC houses some of the most unique facilities in the world.

The ISC Predictive technology Group at Kennedy Space Center utilizes both System Assurance Analysis and RCM2 Analysis on their critical plant equipment to determine the most cost effective job plans for performing maintenance. Critical equipment is that which supports launch related activities that could impact or delay space shuttle launches. Some mission essential equipment (which supports the critical systems) is included as well.

The Vehicle Assembly Building at NASA's KSC is one of the largest buildings in the world.

The ISC Predictive Technology Team

The program has established an in-house training program for thermography, vibration and alignment/balancing. The most impressive part of their program is the alignment and balancing area as can be seen from the following example..

They were experiencing high vibration levels which were leading to shaft and bearing damage and failures in 64 air handling units (AHU's) at the space center. This led to indoor air quality issues in facilities that support launch activities. After diagnosing the problem and completing the repairs and balancing ahead of schedule, the vibration levels dropped significantly and every AHU was well below their target level. This work has significantly reduced shaft and bearing damage and averted many costly repairs. In addition, the AHU's run much more efficiently, which has led to a recurring energy cost avoidance of $26,005 per year.

Best Ultrasound Program – Dmax, Ltd.

Dmax, Ltd., of Moraine, Ohio, manufactures the Duramax Diesel engine for use in General Motors heavy duty trucks. The 650,000 sq. ft. diesel engine manufacturing facility, located on 39 acres, includes machining lines for cylinder blocks, cylinder heads, crank shafts and connecting rods, as well as areas for engine assembly and testing. The facility employs about 540 hourly and salaried employees.

The Ultrasound Program at Dmax, Ltd. has provided a more than substantial return on investment for the company. According to their calculations, the PdM program saved $13,421,714 in potential costs in 2008, and $3,261,380 through the first quarter of 2009. These savings were achieved not only through hard work, but with open minds as well. By trying all of their PdM tools in a wide variety of situations, they are able to see what combination of technologies fits best. The technologies work best when they are used together to identify problems and their solutions.

Here are some examples. After adding Ultrasound for added safety to check main panels before performing the Infrared routes each month, three arcing main panel breaker leads were found last year. In all three of the instances, loose connections were the cause. In two of the panels, the electricians only needed to tighten the connection. However in the third panel, the arcing was so severe the lead welded itself to the breaker, so the breaker had to be replaced as well as the wire. This situation proved not to ever open a panel door without checking it with ultrasound first.

Dmax, Ltd PdM Team

The Dmax facility has over 500 Ball screws in operation, and using ultrasound to trend these has saved hundreds of thousands of dollars. The number of ball screws that can run dry, and need to be lubricated is astounding. Utilizing Ultrasound to monitor and trend the ball screws, has led to an 80% reduction in the number a ball screw failures. In fact, they have now gone over two years without losing a ball screw during production.

Best Specialized Vibration Analysis Program - Peabody Energy, North Antelope Rochelle Mine

Peabody Energy is the world's largest private-sector coal company, serving 330 customers in 21 nations that are located on six continents. It is the leading producer in the coal-rich Powder River Basin of Wyoming, Colorado and the Midwest. The North Antelope Rochelle Mine (NARM) - the largest and most productive mine in North America - shipped a new industry record of 97.5 million tons of compliance coal in 2008 and more than one billion tons since the mine began. Investments in a world-class dragline, blending technology and conveyor systems at the mine have driven productivity while reducing costs.

This vibration program is performed on 12 mining shovels, which can move up to 100 tons per load, and 3 draglines. Their criticality ranking is an informal one based on risk of downtime and magnitude of repair costs. Using these considerations as a guide, they have determined the need to monitor the variable speed components on the shovels and draglines. They intend to add propel equipment as their manpower capability increases. So currently, the program is monitoring three of the four critical motions needed in draglines and shovels. Production will be lost with any of these failures.

Peabody Energy, NARM Maintenance Team

The key element of this specialized vibration program is that they have overcome the short duration cycle time problems presented by the dragline and shovel operations (some equipment operates on an intermittent basis, with durations of only about 5 seconds at a time). Taking up to 16 channels simultaneously allows them to obtain consistent data, record a tach signal, and retain the phase information across all channels. This is all done while causing essentially zero downtime.

Since the vibration analysis program has been implemented there has been a marked improvement in the mean time between failure of bearings on high speed and intermediate speed shafts and improvement in overall unplanned downtime. Job planning and job efficiency has also improved because vibration data has indicated what needs to be replaced with enough lead time to procure the proper parts before the job is performed.

Waiting for Godot?

Quality Data Is Key to Finding Promising Results

by Tracy Smith and Clay Bush

Have you recently implemented an Enterprise Asset Management (EAM) or Computerized Maintenance Management Software (CMMS) System? Did you develop a "Return on Investment" justification for the project, promising substantial improvements in asset performance, reduced equipment downtime, lowered MRO inventory levels and decreased purchasing costs? Did you commit a large amount of money and time to implementation? And are you still waiting for the savings to arrive and those promises to be fulfilled?

If so, rest assured, you are not alone. Sadly, our research indicates that many implementations fail to deliver on promises made to justify the system's cost. This is unfortunate because the possible savings from correctly implementing an EAM software system are genuine and ripe for picking. Significant reductions in maintenance and material costs, improvements in labor productivity and increased operational equipment effectiveness (OEE) are all realistically obtainable.

So what is the problem?

One common thread seems to weave its way through struggling EAM software implementations. Just one problem is at the heart of every troubled asset management operation. That one problem is data.

Struggling companies are unable to generate the data (and the commensurate business intelligence) they need in order to make informed and educated business decisions about their operation to improve asset performance, reduce costs and increase productivity. Specifically, they…

- Don't know the lifecycle costs of their equipment
- Don't know which failures are costing them the most in time and money
- Can't generate accurate inventory usage data in order to optimize inventory levels
- Can't get rich line item detail in order to negotiate purchasing agreements and rationalize the vendor base

It is all about the data. Content is king in EAM. Data is the foundation of information. The challenge of generating insightful and meaningful EAM information starts with your data.

So, why can't our clients generate accurate and meaningful EAM data? Well, here are a few possibilities:

- Processes are not in place.
- Processes are out of control.
- Roles & responsibilities are not clearly defined.
- System training is inadequate.
- Audit process to identify performance gaps is missing.
- EAM System functionality is under-utilized.
- No measurement program is in place to monitor and evaluate processes.
- Equipment and inventory databases are not set up properly.
- EAM System is not properly configured.

All of these variables impact EAM data quality and ultimately information. If we can fix these problems, then we can generate the data we need to properly manage our operation. Best Practice EAM data is clean, consistent, accurate and complete.

- Clean: the data does not contain spelling mistakes, is free of unnecessarily complex syntax and tables do not contain duplicate records.
- Complete: all of the required fields in each record have been populated.
- Accurate: all of the required fields in each record have been populated correctly.
- Consistent: the data is described in a standardized, structured manner and adheres to an agreed-upon naming convention.

EAM data must meet these requirements in order to maximize reporting, analysis and creation of quality information. Primarily, the challenges of generating great data - and, therefore, usable information - fall into three areas: Best Practices, Technology and Performance Management.

Best Practices

Best Practices refer to the most efficient and effective method for executing a given activity or process. Useful and reliable information is driven in part by Best Practices. Data, Processes and People are key Best Practice components that impact information.

Data

EAM data is made up of static and transactional elements. Static data forms the backbone of the EAM System. It is comprised of the Master Table information and Coding Structures, whereas transactional data is created as a result of a process.

The Equipment and Inventory Master Tables are the two key building blocks of an EAM software database. Getting your data right starts with these two tables.

Equipment Table – The Equipment Table contains information on the corporation's assets, such as descriptions, classifications, and locations, starting at the plant level. The Equipment Table should also define the equipment's hierarchical (or linear) asset structure within each plant. A well-defined equipment structure identifies asset relationships and levels, such as parent and child assets. These relationships facilitate analysis both on "roll up" or aggregate levels (such as by plant or by time period) and also on detailed levels (such as by department or per asset). Figure 1 is an example of an enterprise equipment hierarchy.

Inventory Table – The Inventory Table contains the corporate material catalog and information on each plant's spare part inventories. Inventory Item Numbers should be non-intelligent. Leave the intelligence for other fields in the database. Items should be described in a consistent noun-modifier format. Inventory should be classified in multiple ways to improve system sorting and reporting capabilities. The catalog should be global: item records are shared amongst plants and system security allows for corporate visibility of inventories. See the sample inventory data set in Table 1.

EAM Data Coding Structures – EAM coding structures are the most overlooked and under-appreciated data elements in the EAM System. They help to sort, group and organize information. EAM codes such as equipment criticalities, work order types, priorities, statuses, reasons for outage, inventory classes, purchase order types and vendor service codes are all examples of EAM data coding structures that support asset management Best Practices.

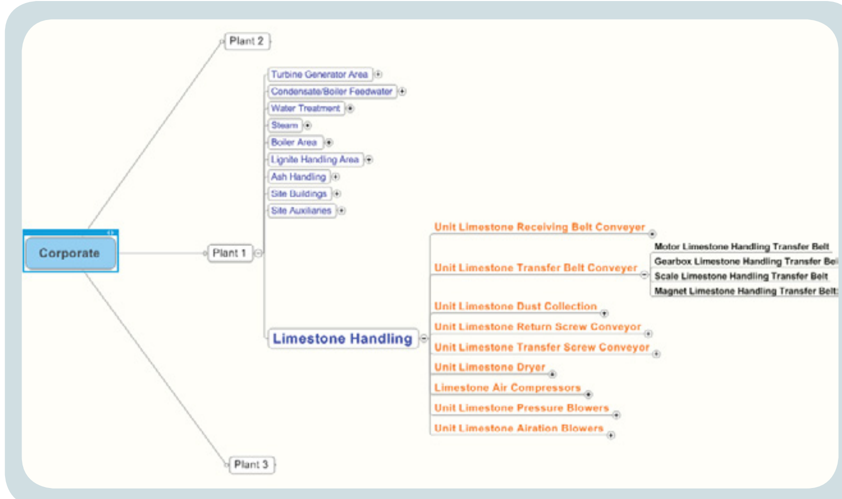


Figure 1 - Enterprise equipment heirarchy.

Item #	Description	Class	Sub-Class	Type
10001	BEARING, BALL 0.3937" ID, 1.0236" OD, 0.3150" WD	MRO	BPT	BEARING
10002	BEARING, BALL 0.7874" ID, 1.8504" OD, 0.5512" WD	MRO	BPT	BEARING
10003	BEARING, BALL 1.1811" ID, 2.4409" OD, 0.9375" WD	MRO	BPT	BEARING

Table 1 - Sample of Inventory Data Set.

EAM codes are also critical to system reporting and analysis capabilities as they are at the core of many key performance indicators (KPIs). For example, a KPI to measure the percentage of reactive maintenance requires that work order coding segregates reactive maintenance work from other types of maintenance work. Table 2 is an example of Best Practice EAM Data Coding structures for Work Order Types.

Developing rich and comprehensive EAM Data Coding Structures allows data to be viewed and reported in a variety of different ways. EAM Data Coding Structures provide insight into maintenance, inventory and purchasing processes, turning transactional data into insightful and meaningful information.

Code	Field Description
CAL	Calibration
CORR	Corrective Work
DEMO	Demolition/Decommission
FAB	Replacement Part Fabrication
IMP	Improvement/Modification - Maintenance
CAP	Improvement/Modification - Capital
PDM	PdM Maintenance Tasks
PM	PM Maintenance Tasks
RBLD	Rebuild/Refurbish Equipment
RP	Repairable Spare
ST	Standing Work Order
TROUBLE	Troubleshooting

Table 2 - Best Practives EAM Coding

Processes

Processes are the system activities supporting the asset. For example, an inventory stock count transaction is created when an inventory item is counted. A work order transaction is created when a work order is entered into the system for a piece of equipment. Transactional Data, mentioned above, is created as an output of a process. EAM Transactional Data is the heart and soul of the EAM system because it drives reporting and analysis outputs and helps to monitor and measure performance. Transactional Data is only as good as the process that is employed to collect it. For example,

- Not issuing materials correctly from the storeroom will result in inaccurate or incomplete inventory usage transactions.
- Not charging parts to work orders will result in inaccurate equipment lifecycle costs.

Processes must be efficient and, most importantly, effective in order to generate good Transactional Data. An inaccurate or inconsistent process will yield sub-standard data. Business rules must be put in place that provide structure and establish guidelines for the process. For example, a work order being required to issue parts from the storeroom. Figure 2 on the following page shows a sample process flow map for the Purchase Requisition Process. Documenting processes is a great way to facilitate buy-in and standardization.

Creating complete and accurate EAM Transactional Data drives reporting, analysis and key performance indicators. Processes must be monitored, measured and audited on a regular basis. Processes must be part of an overall Performance Management Program to ensure continuous improvement and compliance with Best Practice.

People

People execute processes that, in turn, create data. Therefore, people have a significant im-

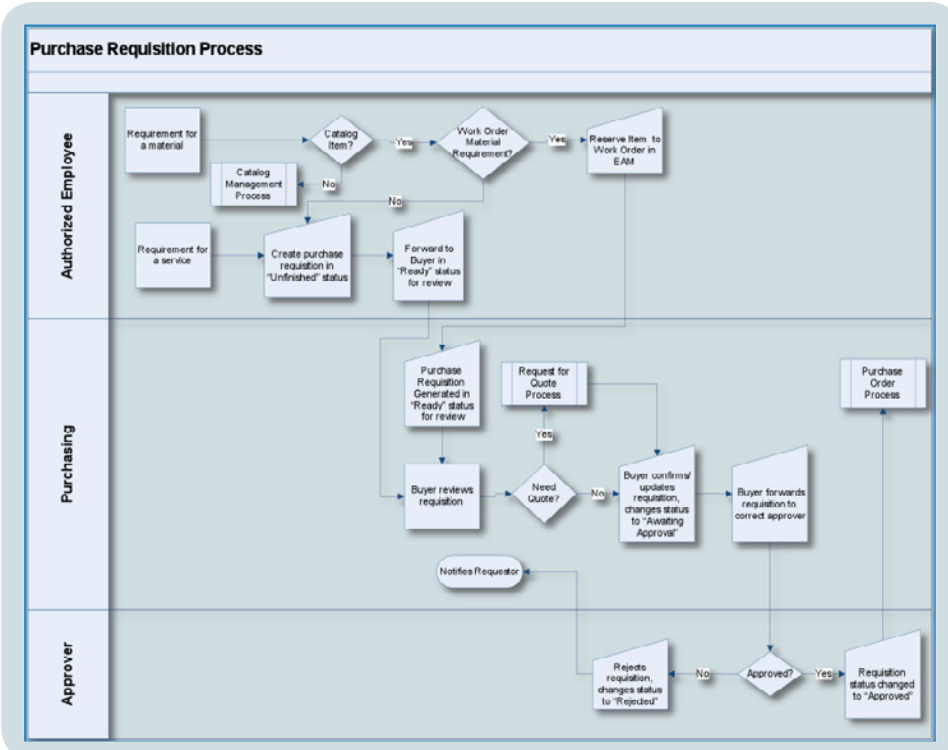


Figure 2 - Process Flow Map for Purchase Requisition Process

pact on data quality, so they must be committed to generating complete and accurate data.

Generating great data requires close coordination and integration of key EAM Functions: Engineering, Maintenance, Materials Management, Purchasing and Accounting Functions form the EAM Value Chain. These functions must collaborate harmoniously and seamlessly in order to properly support asset management and reliability needs. These functions are critically interdependent: no single process can fully accomplish its goals and objectives without the active involvement, respect, and support of the other functions.

Within each function, roles and responsibilities must be defined and audited. Maintenance Planners, Storeroom Clerks, Buyers, Maintenance Supervisors, and others must know their part in generating complete and accurate EAM data. EAM Functions should have their processes documented, internally published and available for personnel use. Everyone in the facility should know how to conduct business with these operations. Together these functions create value in EAM.

Technology

Technology consists of the EAM software and its integration to supporting applications. Technology helps to drive accurate data. Tightly configuring EAM System User Groups and Security Configuration is critical to generating and maintaining accurate data. Only authorized users should have writable access to key areas of the database (i.e., equipment, inventory, vendor tables, etc.). For example, allowing too many people the ability to create equipment records will ultimately lead to inconsistencies in the data.

The setup and configuration of the EAM system should be easy to use. User groups should mirror roles and responsibilities. Busy EAM System forms should be scaled back and focus solely on critical data collection. Unused fields should be hidden from view. The EAM System should frame business processes and facilitate repeatable activities.

A tight-knit and locked down EAM software configuration keeps users on the straight and narrow and facilitates the creation of great data.

Performance Management

Performance Management (PM) is the nexus where clean and accurate data, generated by Best Practices and Technology, is transformed into useful and reliable information. PM tells you how your operation is doing. Is it on track? Is it out of control? Are you obtaining the results that you expect from your practices?

Performance Management involves measuring actual values for specific performance criteria and comparing results to:

- Standards
- Historical values, and/or
- Peer group results

Performance Management consists of Key Performance Indicators (KPIs), Reporting and Performance Audits.

Key Performance Indicators – KPIs measure how well a facility, department or business function (i.e., Materials Management) is performing. For example, measuring Storeroom Inventory Accuracy conveys how well the Materials Management Function is managing inventories.

- Identifying the right KPIs to track and analyze is critical. The right KPIs are directly tied to the department's or organization's objectives and maturity level. For example, attempting to measure Work Order Response Times without an effective Work Request System in place doesn't make much sense.

- Identifying the correct number of KPIs to track and analyze helps the organization remain focused. As the old saying goes, "you can't boil the ocean." Too many KPIs can dilute focus and create paralysis. Conversely, too few KPIs provide an incomplete performance assessment. Important processes go unmonitored and opportunities for improvement are missed.

KPIs exist for all EAM Functions, but don't make the mistake of identifying them in a vacuum. Even though EAM Functions are separate organizations, their activities are integrated. For example, effective planning and scheduling are difficult to achieve without an effective storeroom and purchasing operation. By taking a holistic approach and evaluating the entire EAM Value Chain you will ensure a cohesive vision across asset management operations.

Reporting – EAM System reporting tools are required to extract, aggregate and analyze data. Reporting tools must be user-friendly and facilitate data visualization. Reporting is comprised of three areas: operational, cost & budget and performance reporting.

- Operational reporting focuses on the day-to-day or tactical operations of the facility.
- Cost reporting focuses on labor, material and services costs and how these costs are distributed across the facility's assets.

Operational Reporting	Cost & Budget Reporting	Performance Reporting
Daily Work Schedules	Equipment Failure Costs	Reactive Maintenance %
Inventory Issue Transactions	Inventory Valuation	Inventory Accuracy %
Purchase Receipts…	Purchase Committed to Cost…	MRO Contract Purchase %…

Table 3 - EAM Reporting Examples.

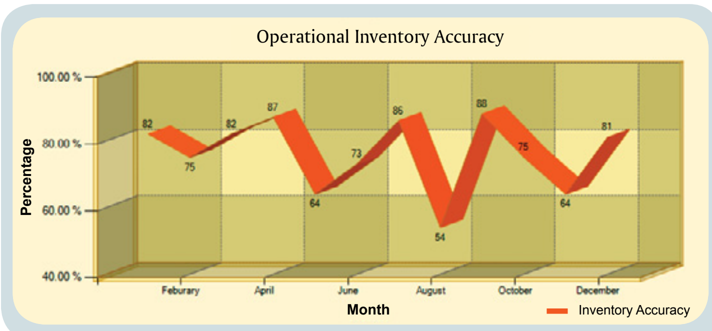


Figure 3 - Enterprise equipment heirarchy.

- Performance reporting focuses on KPI outputs.

Table 3 shows a few examples of EAM Reporting. Information delivery brings data to life. Charts, graphs and tabular reports like the one in Figure 3 are the best way to visualize and trend data.

Performance Audits – EAM Performance Audits are a key component of continuous improvement. Audits keep you focused. In many cases, an EAM System implementation will start quickly out of the gate, enthusiasm will run high, but the process will lose traction and momentum after going live. Periodic audits help to ensure the facility stays on track, continues to improve and closes Best Practice gaps.

Summary

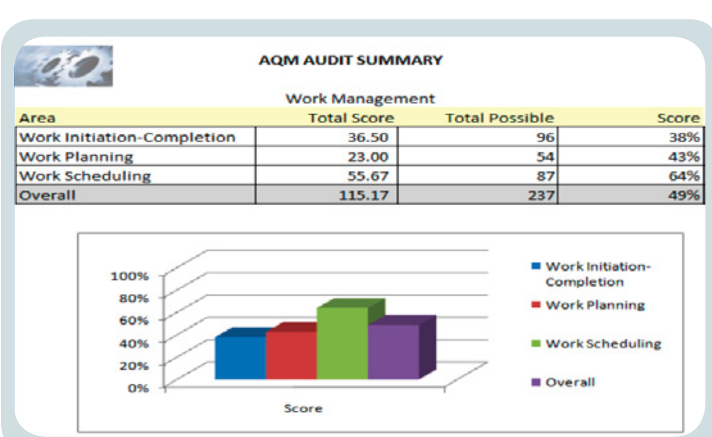
The implementation of an EAM System that creates value across the organization, on a sustainable basis, can be challenging. Integrating systems, people, processes and data requires a well-coordinated and dedicated effort. But the effort it takes is well worth it, as the savings are both real and significant. The key to generating these savings lies in data and information.

- Generating accurate and complete data requires the implementation of Best Practices and EAM Technologies.
- Transforming this data into information requires a Performance Management program built on reporting, KPIs and continuous improvement.

Ultimately, "Success with EAMs" lies in the happy union of Best Practices, Technology and Performance Management.

So take that first step. Identify what is important to your organization. Start with the end state in mind. Define the performance data you need to make educated and informed business decisions. Next, identify the activities and processes required to support this data. Once these designs are complete, implement them and stick with it.

By taking these first few steps you will begin the journey of creating and transforming EAM data into actionable and intelligent business information that creates value across the organization, improves profitability and drives continuous improvement.


AQM AUDIT SUMMARY

Work Management

Area	Total Score	Total Possible	Score
Work Initiation-Completion	36.50	96	38%
Work Planning	23.00	54	43%
Work Scheduling	55.67	87	64%
Overall	115.17	237	49%

Figure 4 - Performance Audits foster continuous imrpovement.

Tracy Smith and Clay Bush are managing partners of Stratum Consulting Partners in Superior, Colorado. Stratum is an Enterprise Asset Management software consulting firm that delivers Application Technology, Best Practice and Performance Management solutions. Clay and Tracy can be reached at 720.2213559 or by e-mail at Tracy.Smith@Stratumcp.com or Clay.Bush@Stratumcp.com

Inspect Your Inspections

NFPA and Its Implications on Infrared Inspections

by Martin Robinson, **I Eng, MInstD,**

The most influential organization in the world for fire prevention and electrical safety is the NFPA. As such, their more than 300 standards have far-reaching implications for companies as they strive to create safer work environments and safer work practices. In many cases, the recommendations of these standards are used by governmental enforcement agencies (such as OSHA), municipal building inspectors and even insurance companies as the basis for mandates being placed on corporations and individuals the world over. This article will explore the standards and their implications on thermographers and electrical preventive maintenance programs.

The National Fire Protection Association (NFPA) was established in 1896 and has become the world's leading advocate of fire prevention. The influence of its 300 codes and standards are evident in buildings, products, and practices throughout the world. NFPA codes are adopted through a broad consensus of experts, and have resulted in some of the world's most referenced and respected codes.

NFPA 70, also known as the National Electric Code (NEC), is the standard developed for electrical design, installation and inspection. It does not specifically address electrical maintenance or safe work practices. For the consensus standards on these topics we turn to NFPA 70B and NFPA 70E respectively.

Although NFPA has no regulatory authority, its codes and standards are widely adopted, or referenced, by agencies such as local municipalities and OSHA – many times making the standards a de-facto regulatory requirement for companies. In fact, in August, 2007, OSHA adopted aspects of NFPA 70E, and the NEC, in a rare revision to its (OSHA's) 1910.303 Subpart S, stating that the agency will "draw heavily from" the 2000 edition of NFPA 70E, as well as the 2002 edition of the NEC.

In other instances, insurers may reference standards as best management practices and may even require aspects of these standards as a requirement for better rates or as a prerequisite for insurability. Many insurers are requiring manufacturers to inspect their critical electrical distribution equipment at least annually, per NFPA 70B.

Dangers of Arc Flash

One of the dangers which these standards are designed to mitigate is the risk of an electrical arc flash. An arc flash is a short circuit (a phase-to-phase or phase-to-ground fault) through the air. Arc flash incidents can be triggered by a variety of electro-mechanical and accidental causes including: dust, corrosion and impurities on contact surfaces; racking of breakers and replacement of fuses; failure of insulating material; leads breaking at connections; accidental contact with conductors with body, tools, bolts or other metal parts.

The arc flash itself can achieve temperatures in excess 35,000°F producing blinding flash, causing copper busbar and cabling to instantly reach a plasma state (the fourth state of matter after liquid and gas) which causes copper to expand more than 67,000 times its solid-state size. This resulting "arc blast" is a bomb-like explosion which releases thousands of pounds of force, carrying with it molten shrapnel and a super-heated fireball which will often blow steel panels off hinges and bolts (see Figure 1, next page). The net result can be total destruction of any plant assets in direct contact with the explosion, and disruption of plant processes. If a thermographer, electrician or laborer happens to be working near the equipment affected by the blast, the effects for the worker and their families could be devastating.

The heat generated by the arc flash can cause 3rd degree burns. The pressure wave from the explosion can rupture internal organs, damage hearing and cause injuries if the worker is thrown into other structures. The shrapnel and flying panels can have obvious effects as they rip through the air, and potentially through any people, in the vicinity of the explosion.

Each year across North America, 5 to 10 serious arc flash incidents occur each day, resulting in the need to treat over 2,000 workers in burn centers (it is estimated that many more occur that only require emergency room attention and, therefore, don't get categorized in studies). The financial costs of flash accidents are estimated in the hundreds-of-millions of dollars a year, while the effects on those workers, and the lives of their families, cannot be represented in mere dollars and cents.

NFPA 70B

NFPA 70B is a standard for implementing an effective Electrical Preventive Maintenance (EPM) program. "The purpose of an EPM program is to reduce hazard to life and property that can result from the failure or malfunction of electrical systems and equipment." It states

HAWK I.R.
A Fluke Company

Increase the safety and speed of thermal inspections with C-Range IR-Windows

Concerned about arc-flash and wish to continue your infrared thermography program—infrared windows are the answer.

Arc-resistant, outdoor certified, infrared windows allow thermal, ultraviolet, visual and fusion technologies to be used without exposing personnel to live equipment.

- 50 kA arc resistant design
- UL/cUL/CSA approved
- Outdoor and indoor certified

Any voltage
Any camera
Anywhere

For more information call 1-800-760-4523 or visit www.fluke.com/irwindows

Only the best IR-Windows have Quadraband optic technology—don't accept imitations.

QUADRABAND™
OPTIC TECHNOLOGY

INFRARED EVOLVED™

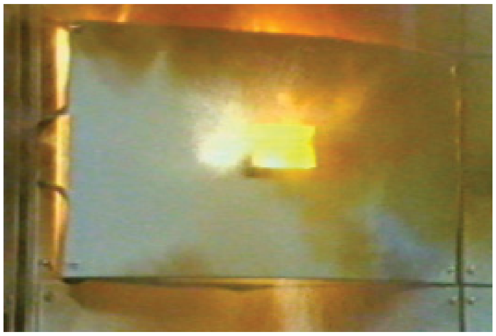


Figure 1 - Steel panel being ripped from its hinges and bolts during an arc blast in an enclosure with no arc resistance mechanisms. Note the hole blown through the solid steel panel.

that "a well-administered EPM program will reduce accidents, save lives, and minimize costly breakdowns and unplanned shutdowns of production equipment." "Without an EPM program, management assumes a greatly increased risk of a serious electrical failure and its consequences."

70B goes on to state that "dependability can be engineered and built into equipment, but effective maintenance is required to keep it dependable." "Electrical equipment deterioration is normal, but equipment failure is not inevitable. As soon as new equipment is installed, a process of normal deterioration begins. Unchecked, the deterioration process can cause malfunction or an electrical failure... An effective EPM program identifies and recognizes these factors and provides measures for coping with them." 70B outlines the following benefits of an EPM program:

Asset Protection – "Experience shows that equipment lasts longer and performs better when covered by an EPM program."

Risk Management – "An EPM program is a form of protection against accidents, lost production, and loss of profit."

Energy Conservation – "Equipment that is well maintained operates more efficiently and utilizes less energy."

Increased Uptime and Profitability – through "reduced interruption of production" and "better workmanship and increased productivity"

Improved employee morale and reduced absenteeism

Possible Reduction in Insurance Costs – due to the alternative "high cost of inadequate maintenance."

NFPA regards systematic and regular thermographic electrical inspections to be a critical part of an EPM program stating that " these (thermographic) inspections have uncovered a multitude of potentially dangerous situations. Proper diagnosis and remedial action of these situations have also helped to prevent numerous major losses... They can reduce typical visual examinations and tedious manual inspections and are especially effective in long-range detection situations." It goes on to endorse thermographic electrical inspection as "relatively inexpensive to use considering the savings often realized by preventing equipment damage and business interruptions...(and is) considered a useful tool to evaluate previous repair work and proof test new electrical installations and new equipment still under warranty."

The 70B standard prescribes "routine infrared inspections of energized electrical systems should be performed annually prior to shutdown. More frequent infrared inspections, for example, quarterly or semiannually, should be performed where warranted by loss experience, installation of new electrical equipment, or changes in environmental, operational, or load conditions."

Temperature Range	Interpretation	Prescriptive Action
1°C (1.8°F) to 3°C (5.4°F)	Indicates possible deficiency	Warrants Investigation
4°C (7.2°F) to 15°C (27°F)	Indicates deficiency	Repairs should be made as time permits
16°C (28.8°F) and above	Indicates major deficiency	Repairs should be made immediately

Table 1 - NETA benchmarks for temperature and corrective action

70B also prescribes temperature benchmarking and references the NETA benchmarks as seen in Table 1. The NETA table compares temperatures to “normal” (as “determined by a qualified technician”) and prescribes a corrective action based on those deviations from “normal.”

It is important to remember that temperature (T) and differential temperatures (ΔT) measurements are only as accurate as the optic through which the object is being viewed. Therefore, it is imperative that users of infrared windows, or viewing panes, compensate for any attenuation in transmission.

The standard is also very specific about performing “running inspections” (inspections made with equipment operating) and requires that “infrared surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected.” In instances where IR Windows or viewing panes are not available, “equipment enclosures should be opened for a view of components whenever possible...” since it is not possible for infrared imagers to calculate internal temperatures through standard panel covers or standard materials used in visual inspection panes (ie. tempered glass or Plexiglas) as these materials are non-transmissive in the infrared spectrum.

Of course, when thermographers and electricians open electrical panels to perform thermographic inspections per NFPA 70B guidelines and insurance requirements, they increase the risk of allowing one of these triggers to occur. NFPA 70E rates the removal of bolted panels on electrical equipment in the highest hazard/risk category. Consequently, NFPA 70E standards for electrical safety must be followed.

NFPA 70E

Originally chartered in 1976 and first released in 1979, the 70E standard is “intended for use by employers, employees, and OSHA.” Its purpose was to assist OSHA in preparing a set of consensus standards to be used as a basis for evaluating electrical safety in the workplace. Through its eight revisions over roughly 30 years, the NFPA 70E Standard has made an indelible mark on safe work-practices throughout the US, and the world. However, its greatest impact has only been recognized since the 2000 revisions, which included clarification of PPE (personal protective equipment) requirements. In part, the current 70E Standard requires employers to:

- Perform a Flash Hazard Analysis to define Arc Flash Boundaries and document the incident energy levels of related equipment or consult the 130.7(C)(9) tables
- Provide workers with appropriate levels of PPE
- Allow only qualified personnel to work on or near live parts
- Train workers on electrical safety and safe work-practices
- Use safety signs, symbols and accident prevention tags
- Provide tools for safe work

Hierarchy of Control

At the heart of NFPA 70E and OSHA initiatives is the hierarchy of control (as referenced in Annex F of the 2009 edition of 70E). Put simply, this concept attempts to control or mitigate risk wherever possible. In order of preference, the hierarchy of control seeks to mitigate risks by:

1. Risk Elimination
2. Substitution (with lower risk)
3. Engineering Controls (such as arc resistant switchgear)
4. Safe Work Practices
5. PPE

In short, the best way to reduce risk is to eliminate it. This is why NFPA 70E and OSHA state very plainly that electrical equipment should be de-energized prior to opening. Realizing that this is not always possible for troubleshooting, inspecting or in situations where shutting down is not viable or poses a risk, there is an allowance made for PPE to be used as a last resort – similar to the least preferred method in the hierarchy of control.

The OSHA 1910.303 Linhardt Interpretation states clearly that "...with respect to arc-flash burn hazard prevention, the general provisions for the selection and use of work practices...generally require de-energization of live parts before an employee works on or near them."

Although OSHA recommends that "employers consult consensus standards such as NFPA 70E-2004," they fall short of fully endorsing the 130.7(C)(9) charts for PPE recommendations. Furthermore, they are on record in the Linhardt Interpretation as saying that some of the PPE protection, and lack of lockout/tagout (LOTO) requirements, don't offer workers as much protection as offered in Subpart S.

Keep in mind that OSHA's mandate to employers is to eliminate risk of work-place injury wherever possible and practical. To this end, PPE will always fall short of OSHA's goal of zero-tolerance. The 2009 edition of the 70E (130.7(A) FPM No.1) plainly states the limits of PPE:

"The PPE requirements of 130.7 are intended to protect a person from arc flash and shock hazards. While some situations could result in burns to the skin, even with the protection selected, burn injury should be reduced and survivable. Due to the explosive effect of some arc events, physical trauma injuries could occur. The PPE requirements of 130.7 do not address protection against physical trauma other than exposure to the thermal effects of an arc flash."

NFPA 70E and Thermography

New language has been introduced into the 2009 edition of NFPA 70E. Among other changes, the most notable for thermographers is the addition of infrared thermography as a task noted in the Hazard/Risk Classifications Table 130.7(C)(9).

The now-famous Hazard/Risk Classifications Table attempts to guide workers and managers to appropriate levels of PPE when complete incident energy analysis ("arc flash hazard analysis") has not been performed. The table makes certain assumptions about "...maximum short-circuit capacities and maximum fault clearing times..." Systems falling outside those assumptions require a full analysis.

The rating for "perform(ing) infrared thermography and other non-contact inspections outside the restricted approach boundary" has been given a hazard/risk category equal to that of "opening hinged covers (to expose bare, energized electrical conductors or circuit parts)" – which is a category 3 (out of 4) hazard on 1kV to 38kV switchgear. Removal of bolted covers so that inspections can be performed still carries a category 4 (out of 4) hazard/risk in most applications 600V and higher.

Figure 2 - Example of a thermographer using an IR window and wearing standard level of PPE required while operating energized electrical equipment in an enclosed and guarded condition.

So the message is clear that preparing a cabinet for open-panel thermographic inspection, and performing open-panel thermographic inspections are high-risk activities which require precautions including use of proper PPE to protect workers from the possible thermal effects of an arc flash. But remember, it is not only high-risk for workers; it is also high risk for processes and plant assets, which, in turn, means a risk to profits.

Enclosed and Guarded

IR windows incorporate a specialty lens (typically made of a polymer or crystal) which allow the infrared wavelengths to transmit through the optic, ultimately to be captured and interpreted by an infrared imager or camera. Infrared windows can be installed in the covers or doors of electrical distribution equipment such as switchgear, transformers, MCC's, PDU panels and motor termination boxes to name a few.

Because IR windows allow thermographers to perform thermographic inspections while leaving the panel covers and doors closed (Figure 2), thermographers are not "exposed to energized conductors and circuit parts" and they are not "breaking the plane" of the cabinet. In NFPA terms, the electrical cabinet remains "enclosed" and the energized conductors and circuit parts are maintained in a "guarded" condition. The state of the inside of the cabinet, therefore, is not changed and the hazard/risk level is the same as if the thermographer was simply walking by the equipment in question.

Ultimately, by utilizing this closed-panel inspection process, companies will eliminate 99% of arc flash triggers during an infrared electrical inspection. Or, as stated in NFPA 70E: "Under normal operating conditions, enclosed energized equipment that has been properly installed and maintained is not likely to pose an arc flash hazard." This is why the scope of the PPE requirements in 70E are restricted to "electrical safety-related work practices and procedures for employees who are exposed to an electrical hazard..." Workers who are using "enclosed" and "guarded" equipment which is "properly operated," "properly installed," and "properly maintained" are not exposed to an electrical hazard and are, therefore, not required (per 70E) to utilize elevated levels of PPE.

However, in the event that the purpose of the inspection is to troubleshoot a suspected fault, which could cause an arc flash, then employers and thermographers would be prudent to take all applicable precautions (consistent with 70E Article 130.3(I) – including the use of appropriate PPE, because "...in most cases closed doors do not provide enough protection to eliminate the need for PPE for instances where the state of the equipment is known to readily change..."

Simply put, infrared windows are not a "protective device" and no window on the market is as structurally sound as the steel which is so easily ripped apart in un-vented blast.

All three major manufacturers of infrared windows have performed various 50kA arc resistance tests on switchgear with infrared windows in place. These tests only confirm that the windows or other components did not fail in a closed position, and that they did not interfere with the safety mechanisms in the arc resistant switchgear. It is the design of arc resistant switchgear, not infrared windows, which will redirect the forces and heat of the blast away from panel doors and away from personnel.

IR windows, like the visual viewing panes or panel meters commonly included in arc resistance tests, are a preventative device. They are intended to maintain a separation between thermographer and energized components, and thereby eliminate increased risk to the thermographer or other workers triggering an arc flash.

Summary

The NFPA has had far reaching impacts on improving the safety of electrical equipment and safe work-practices, not only in the United States, but throughout the world wherever the standards are adopted.

Companies looking to improve profitability, uptime and safety should study the recommendations in the NFPA 70B Standard for Electrical Preventive Maintenance. To further bolster safety and reduce risk to plant and personnel, the 70E standard is all but required reading, especially since OSHA regulators carry a copy of the standard with them as a reference for electrical safety in the workplace.

It is significant that the standards value thermographic electrical inspections as a critical part of an EPM program. IR windows have now provided a way for companies to comply with the recommendations for inspection processes, while complying with the mandates for arc flash avoidance.

NFPA and OSHA agree that electrical equipment should not be opened unless it is de-energized. However, exceptions to this rule are made for conductors and circuit parts under 50V, as well as instances where de-energizing the equipment will create greater risks , or for tasks where putting the equipment in a de-energized state would be “infeasible.”

Infrared windows offer companies and thermographers a safer, more efficient way to perform an inspection while maintaining an enclosed and guarded condition for the energized conductors and circuit parts. They also preserve a steady-state inside the cabinet. This closed-panel inspection process will eliminate the increased level of risk associated with open-panel inspections, and eliminate the requirement for elevated levels of PPE.

IR windows help companies to comply with standards and speed inspection time, while also improving safety for thermographers, plant assets and processes. Ultimately, infrared windows help companies save time, save money and stay safe.

Martin Robinson, I Eng, MInstD, is a highly sought after trainer and speaker for topics including infrared windows and general thermography, electrical preventative maintenance, condition based monitoring, “green energy,” and electrical safety standards. With over 15 years of practical field experience, Martin’s expertise is also valued on various committees, such as the British Institute for Non-Destructive Testing - InfraRed Training Working Group (which for establishes the training standards and working practices for Thermographers in the UK). In 1997, he founded Global Maintenance Technologies, which provides Condition Monitoring, and energy management services to some of the most recognizable and prestigious landmarks, organizations and businesses in London and Southeast England. Martin also formed IRISS, Inc, which produces the world’s only industrial-grade infrared windows capable of passing durability and impact requirements, the world’s first ultrasound ports; emissivity standardization “landmarking” tags, and the world’s only transmissive PDU panels; and other groundbreaking solutions released continually. Residing in Sarasota, FL, Martin is a devoted husband and the proud father of 8. He can be contacted at m.robinson@iriss.com

Choose Your Partners Wisely

Or Discover Another Reason Why PdM Programs Can Fail

by Alan Friedman

Many companies have failed to experience the 10:1, 20:1 or even 30:1 ROI promised with the adoption of a Predictive Maintenance (PdM) or Condition Monitoring (CM) program. In recent years, the industry has seen a trend towards outsourcing these monitoring functions to experienced third parties. This article will explore one aspect of why in-house programs often fail to produce the expected rewards, namely a lack of good partnering, and how this knowledge can be used to revamp a dead program or select the best partner to help you manage it or manage it for you.

A Bit of History

Back in the 80's and earlier, vibration analysis was carried out by a few consulting companies who were experts in using complex equipment to collect and analyze vibration data. In some cases, individual plants or companies employed in-house experts to monitor key assets, such as steam turbines, but generally the expertise was relegated to specialized companies. As digital computers became the norm and digital data collectors and software came on the scene, many companies purchased this equipment and attempted to evolve their maintenance practices. These efforts produced a variety of results ranging from good long term successes and huge returns on investment to money spent on equipment that now sits on a shelf and training for long gone employees.

In general, the concept of PdM has been well accepted; the problem now is how to create a successful program and keep it running year in and year out. Some facilities have given up completely, others are looking to gain or maintain their in-house expertise and others are looking to outsource these functions entirely. Current trends seem to point to the latter option as being the most common as companies can now establish partnerships to either completely hand over their PdM program or combine in-house manpower with external expertise.

Successful Programs Depend on Consistency

One reason many in-house programs fail is a lack of consistency on many levels. A successful PdM program relies on long-term consistency on the technical level in terms of collecting repeatable data for trending. This means that assets must be tested the same way time after time, year after year, in terms of test speeds, loads, test positions, test types etc. Consistent testing ensures accurate trending of machine condition, the development of meaningful baselines and alarm criteria and, therefore, accurate fault diagnosis and repair recommendations. This is very different from the process of using the technology to troubleshoot an asset. Troubleshooting is a valid use of these technologies, but does not result in a change in maintenance philosophy, nor does it provide the large ROI's such a change in philosophy should produce.

On a higher level, such technical consistency also depends on the reliability of management and personnel. Oftentimes, due to lack of financial justification, PdM programs are stopped and personnel are reassigned to different tasks. New maintenance managers may not understand the technology and may recommend a new approach to using – or not using – it which disrupts the consistency of a program. In-house "experts," in seeking to keep their jobs secure, may not document or follow fixed procedures for monitoring equipment or share information with others, causing programs to fail when they leave for greener pastures.

There are many reasons why programs bloom and then decay. People who have different ideas about how PdM should be done come and go, priorities change, technology changes, expertise changes and approaches change. The one sure thing is that all of these starts and stops and changes in direction ensure a program will never be successful. This is another reason why an external partner is a good option to keep the program running steadily regardless of what is happening within the maintenance department of your facility.

In general, it can be said that a good PdM program requires a consistent approach, with a clear set of objectives that can be measured to monitor the success or failure of the program. The program must continue to remain consistent through good times and bad, regardless of who in the facility (or outside the facility) is running the program, collecting data, analyzing it or writing reports. This sort of consistency is often difficult to maintain within a facility, and is an example of where a good partnership with a PdM service provider can be a huge asset. Especially if this partner has a long track record of managing successful PdM programs and has a well-defined approach to managing such programs. This is different from hiring a vibration expert to come on-site at times to troubleshoot machines or structures.

A Good Partner Has the Right Tools and Approach

A good partner will promote a specific methodology or approach to condition monitoring, will help you understand its goals and set up in-house procedures to manage the program and measure its results. The partner is not just someone who can tell you what all of the buttons on the data collector do or how to install your software, nor is it someone who will spend most of their time training you on how to interpret graphs. A successful program depends more on methodology and consistency than analysis prowess.

Regarding tools, a good partner should provide or recommend software that facilitates trending, baseline and alarm configuration and reporting. Another common feature in some of today's packages is the ability to easily share information over the web. This allows your partner to help you when you need it, simply by logging onto your database in order to check test setups or baselines, or to help you analyze data or review your recommendations. In the long term, this allows you to outsource program management to the service provider when times are lean and your workforce is stretched to their limits, or when an in-house expert leaves. Later, your partner may help train a new employee and move the program back into your hands. It is exactly this sort of back and forth, getting help with your program or even outsourcing the work from time to time, that makes partnering so important and keeps programs running smoothly from year to year.

Program Audits

Regarding methodology, if your partner has set up your program correctly, or helped you set it up correctly, then all of the procedures will be well defined and documented. This allows your partner to occasionally audit your program to make sure the physical equipment in the plant matches the information that has been entered in your software. For example, if the software defines a test point as being in the vertical direction on the motor free end bearing, but the motor itself has a sensor mounting pad installed only on the motor coupled end bearing in the horizontal direction, then there is a discrepancy that needs to be resolved. It is exactly these sorts of issues that cause programs to fail – not the debate over which point is the better one to test, but that the machine is always tested at the same point, and that this point is correctly defined in the software.

On a similar note, a good program will include the management of asset information to ensure that the actual machine in the plant you are testing today is identical to the machine you entered in your software five years ago. Oftentimes motors are replaced with similar motors of a different make or model, but these changes are not updated or accounted for in the monitoring program. Documenting and periodically auditing this information for accuracy is an important component of a successful program, and a component that a good partner can help you with.

Ongoing Training

As noted earlier, many successful long-term programs are those that take advantage of a reliable partner to go back and forth between in-house and outsourced in varying capacities whenever necessary. Although there are many professional benefits to certified training classes and in learning how certain technologies work, they are not a replacement for in-house, on-site courses that involve reviewing your application, actual database, baselines, reports, questions and concerns. It is one thing to understand how it is done; it is a very different thing to do it yourself successfully. In order to do the latter, it helps to have a partner come in, review your work and answer questions, or collaborate online to have them remotely view your database.

On site training should not be limited to how to use a software or hardware product and understand its features, nor should it be relegated to data analysis. Both of these topics are useful and important, but do not lead directly into the proper management of a good long-term program. On-

Webinar Guide Listing

Risk, Reliability and Root Cause Analysis by Mark Galley, ThinkReliability
Thursday, January 7, 2010
Start time: 10:00 pm EST • Length: 45 minutes
To Register: Go to http://www.thinkreliability.com/root-cause-analysis-webinars.aspx

Fundamentals of Reliability by Mike Howard, MSc, CMRP, CSSBB, Director of Customer Success
Wednesday, January 13, 2010
Start time: 12:00 pm EST • Length: 1 hour
To Register: Go to www.commtest.com/cst/webinar

The Predictive Service Institute by Predictive Service®
Wednesday, January 13, 2010
Start time: Ongoing (see website for details)
To Register: Go to http://www.predictiveservice.com/Institute/

ROI Case Study 1: Paper Mill Saves Budget Dollars with IR Window Program by Martin Robinson, IRISS
Thursday, January 21, 2010
Start time: 1:00 pm EST • Length: 1 hour (30 minute webinar, 30 minute Q&A)
To Register: Go to https://www2.gotomeeting.com/register/431036211

Planning & Scheduling for Maintenance by Joe McAfee, Marshall Institute
Friday, January 22 & 29, 2010
Start time: (see website for details)
To Register: Go to https://www.marshallinstitute.com/default.asp?Page=MT&Area=Elearning&Sub=MPS

PAS-55: An Introduction to the Asset Management Standard by Mike Schultz, APG
Thursday, February 11, 2010
Start time: 1:00 pm EST • Length: 45 minutes (30 minute presentation, 15 minute Q&A)
To Register: Send e-mail to info@apgassetcare.com

Can You Beat The ABB Reliability Challenge? by ABB
(see website link for details)
To Register: Go to http://www.abb.com/reliabilitychallenge

For more webinar listings, please log onto www.reliabilityweb.com.

site training should be a combination of theory and actual review, help and support in setting up and managing your program on an ongoing basis. Once your PdM program has matured, the on-site training and support should evolve its focus towards Proactive Maintenance, Reliability, Performance Monitoring or other levels of competency that can be attained only after an effective PdM program has been in place for some time.

Economic Justification

A good PdM program should earn you money. A good PdM partner should be able to help you see the bigger picture and monitor the efficacy of the program in financial terms. It is often difficult to quantify the cost of an averted failure, we don't often consider that our airplane did not crash this trip due to all the money we put into testing and maintenance, but we certainly become aware of the costs and implications when an airplane does crash! Sometimes the economic justification is done in these terms and we have to remind ourselves that failures are constantly being avoided, perhaps by comparing current performance to prior performance, looking at reductions in orders for spare parts and a reduction in planned and unplanned downtimes etc. You might also look at key performance indicators (KPI's) such as Overall Equipment Effectiveness (OEE) to measure the impact that PdM technologies are having on the profitability of the plant. In any case, a good partner should be in a position to help justify your program and calculate the return on investment.

Conclusion

Whether you are considering starting a new program, revamping a dead one, outsourcing or looking for someone to become a long term partner to step in when needed and step back when not needed, make sure you pick the correct partner. The company should have a good track record of managing successful programs, should use good equipment for the job, and should make necessary equipment available to you as part of a sale or service or as a lease as needed. Make sure your partner can train staff at all levels, from using the products to analyzing graphs, but, more importantly, is capable of managing your particular program and answering specific questions related to auditing your program. The importance of helping you calculate the economic impacts of these technology and maintenance practices to your bottom line can not be underestimated.

More than anything, consider that choosing the right partner may make the difference between a consistent and effective program that runs smoothly over the next ten or twenty years and an endless series of false starts and investments in misused equipment. One thing is for sure, successful programs, more often than not, involve good partners.

Alan Friedman is a senior technical advisor for Azima DLI (www.AzimaDLI.com). With more than 18 years of engineering experience, Friedman has worked with hundreds of industrial facilities worldwide and developed proven best practices for sustainable condition monitoring and predictive maintenance programs. Friedman contributed to the development of Azima DLI's automated diagnostic system and has produced and taught global CAT II and CAT III equivalent vibration analysis courses. Friedman is a senior instructor at the Mobius Institute, an independent provider of vibration training and certification, and an instructor for the Instituto Mexicano de Mantenimiento Predictivo (Predictive Maintenance Institute of Mexico). He is also the founder of ZenCo, a positive vibrations company. You can contact Alan at 206-327-3332 or at friedmanalan1@gmail.com

More Data Provides More Answers

A Better Understanding of Rotor Dynamics and Support Stiffness

by Ron Brook

If you're responsible for maintaining motors, you may have sent units off to be reconditioned, only to see them demonstrate high vibration levels once they're back on the foundation—and uncoupled to boot!

So now what? Your vibration technicians may be reporting high 1x vibration levels, which may point back to the repair facility. If they've documented their work, the repair facility will have data from the final test stand run indicating that vibration levels are well within satisfactory limits. Both answers can't be correct. Or can they? Rather than waste time arguing with the repair shop, I suggest a more efficient approach—take more data. Chances are there's critical information being overlooked and it can usually explain your problem. If your vibration technicians don't know the answer, then they're not asking the right questions—the kind that can be answered with more data or taking a closer look at the motor's mounting and foundation.

Vibration data that includes a peak average coastdown spectrum will help isolate your problem. These readings will clearly identify any areas where the resulting high vibration is due to resonance (resonance is the condition where a natural frequency is close to—and thereby excited by—a forcing function, such as 1x operating speed due to residual imbalance). Impact data, when properly collected, can also identify natural frequencies. You have to be careful to impart sufficient energy in the frequency range of interest, using a soft tipped hammer with a large attached mass. If sleeve bearings are present, the rotor must be at a slow roll and not at rest. Failure to do this will couple a portion of the shaft stiffness into the end brackets, which will then yield erroneous information.

Let's start with a little background on what we're measuring. Induction rotor construction isn't complicated: a solid steel shaft, thousands of thin laminations and either solid or cast bars connected to end rings. Modeling this rotor to identify its natural frequencies is easy, as a simplified 2D finite element program uses shaft lengths, diameters and material properties.

Figure 1 shows a model of a 1000 HP 2-pole motor (the laminations, bars and end rings are modeled but not shown). The 2D model requires a support stiffness that most closely approximates the structure supporting the motor—a motor bolted to a 2-inch sole plate,

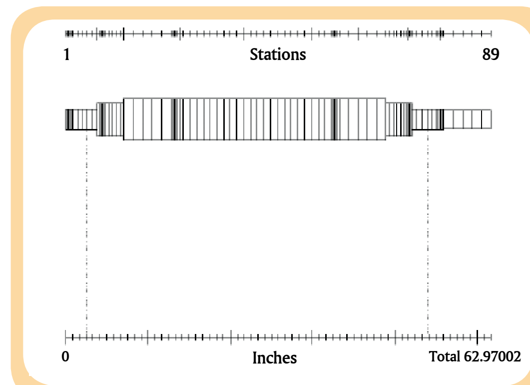


Figure 1 - Shaft-only model of 1000 hp 2-pole motor.

for example, embedded in grout that's part of a 16-inch thick substrate. You, as the equipment operator and the primary construction contractor, are responsible for the equipment foundation. You must ensure that the rigid body modes don't end up near major forcing functions, such as 1x and 2x running speed. In addition, the floor concrete must have been poured properly, with two feet of crushed stone underneath, for an equivalent support stiffness of approximately 400,000 lbs/inch. For whatever reason, your motor may not sit on a foundation this robust (most industrial applications using I-beam base construction have an equivalent support stiffness of approximately 100,000 lbs/inch, which is far from optimum).

There are other applications where the foundation has been designed specifically for lower stiffness, similar to the isolation pad testing. In these applications, the entire driver and driven units are isolated. This guarantees that the first two rigid body modes are well below operating speed. However, anything that the installation contractors do to compromise this isolation will cause excessive vibration for the same reason—the stiffness has now changed and the rigid body mode now coincides with operating speed. Other issues that can cause vibration include bottoming out of spring isolators or isolators that are incorrectly adjusted.

When we talk about lateral modes, remember that there are rigid body modes and bending modes. The motor design engineer can predict the bending modes, since they're predicated on shaft stiffness and rotor mass. Most machinery has bending modes higher than twice operating speed. There are, however, machines that operate above the first and even the second bending mode (steam and gas turbines, for example). Some large motor frames operate above the first bending mode. You and the primary construction contractor responsible for the foundation have to ensure that the rigid body modes don't end up near those major forcing functions, like 1x and 2x operating speed.

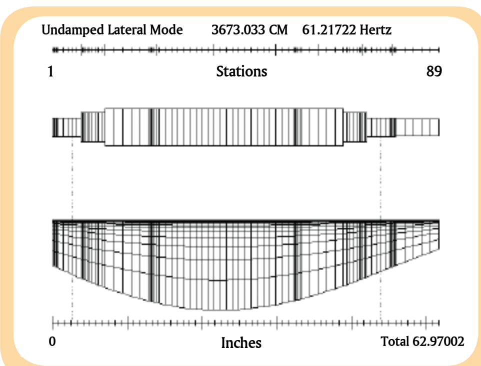


Figure 2 - First Rigid Body Mode

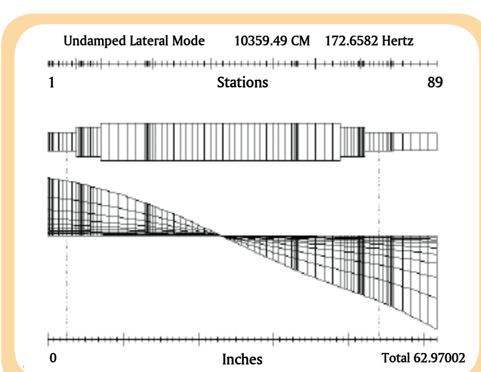


Figure 3 - Second Rigid Body Mode

Figures 2 and 3 show the rigid body modes, with no bending in the shaft (you can see from the mode response that the bearing phases will be in phase for the first mode and out of phase for the second).

Figure 4 shows the first bending mode. You can see its frequency is 21,556 cpm or more than 3x operating speed for this 2-pole motor. You can also see that the mode shape curve crosses the center line, indicating true bending. The displacement at the bearings is out of phase for this mode.

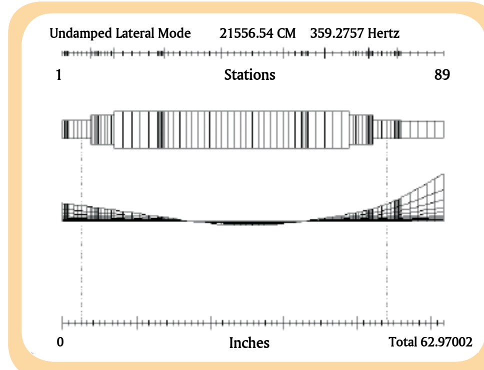


Figure 4 - First Bending Mode

The critical speed map results in Figure 5 are the key to understanding what's happening with your reconditioned motor, now vibrating on its foundation. Note that a base stiffness somewhere between 50,000 lbs/inch and 100,000 lbs/inch is ideal for this motor. If your foundation is such that the equivalent support stiffness is close to 30,000 lbs/inch, then the second rigid body mode of the motor would be excited and the resulting vibration severe (this particular motor's first rigid body mode is excited by an equivalent support stiffness near 200,000 lbs/inch; the red 1X running speed line coincides with the first rigid body mode curve). Equivalent support stiffness is the total stiffness in series from the bearing down to the earth. The weakest link in that stiffness chain largely determines the equivalent support stiffness.

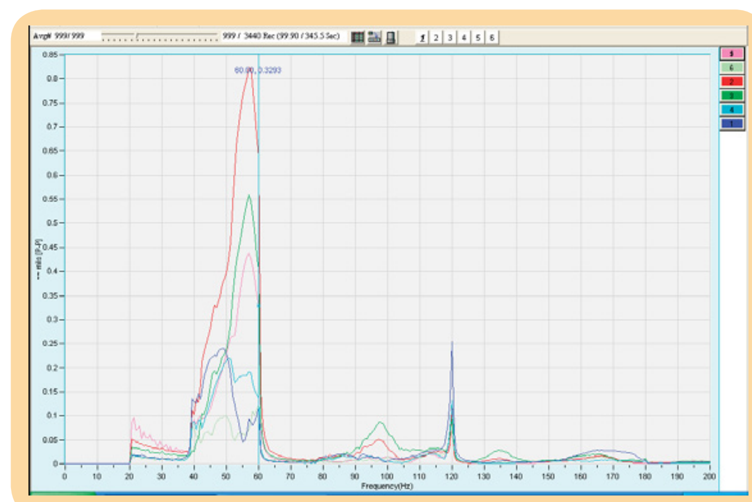


Figure 6 - Peak Averaged Spectra on Coastdown

Our example also illustrates that no matter what you change in a typical support stiffness setting, the first bending mode will be unchanged. The NEMA standard for testing motors on isolation pads is based on understanding the critical speed map. The isolation pads lower the equivalent support stiffness to the 1000-10,000 lbs/inch range, moving both rigid body modes well below running speed. The deflection of the isolation pad must be to specification—too soft or too hard and your motor could be in a rigid body mode on a test stand with very high vibration results.

This often happens with large 2-pole sleeve bearing motors. The specification calls for approximately a 10% deflection of the isolation pads due to motor weight, which must be verified to prevent excessive vibration on the test stand.

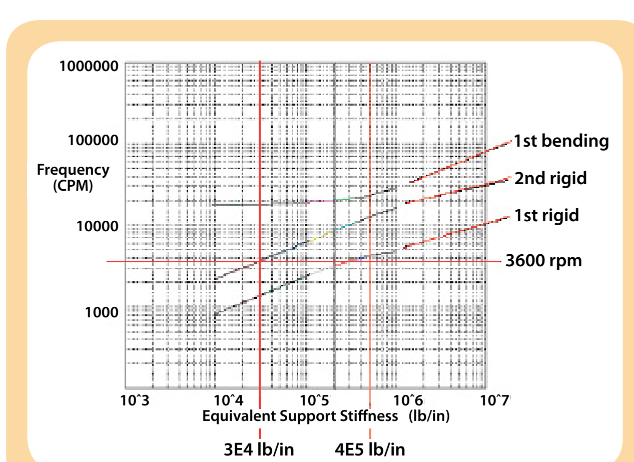


Figure 5 - Critical Speed Map

You should also review a peak hold averaged spectrum to identify natural frequencies that might be close to operating speed. Figure 6 is an example of a coastdown on a large 2-pole motor in all three axes on both bearings. The motor was operating at 3585 rpm when the data averaging began and technicians then cut the power to the motor. The processor saved every amplitude data value during the coastdown until the process was stopped at approximately 20 Hertz, or 1200 RPM. Note that the amplitudes in three of the locations actually increase as the speed dips below 60 Hz. This identifies the residual imbalance exciting a natural frequency and driving it into resonance.

Figure 7 is an example taken on a large fan in the HVAC system of a 55-story building (20% of the building would be affected by the loss of this fan). The fan operated over a speed range as low as 200 rpm to 405 rpm. The peak average plot in Figure 7 captured the vibration over the entire operating range, revealing a resonance condition in the fan bearing pedestal nears 307.5 rpm. These fans were originally fixed-speed units. With the addition of variable frequency drives, it became apparent that there were speed ranges that had to be avoided. This unit now has a speed range that is blocked out to eliminate staying at the problem speed.

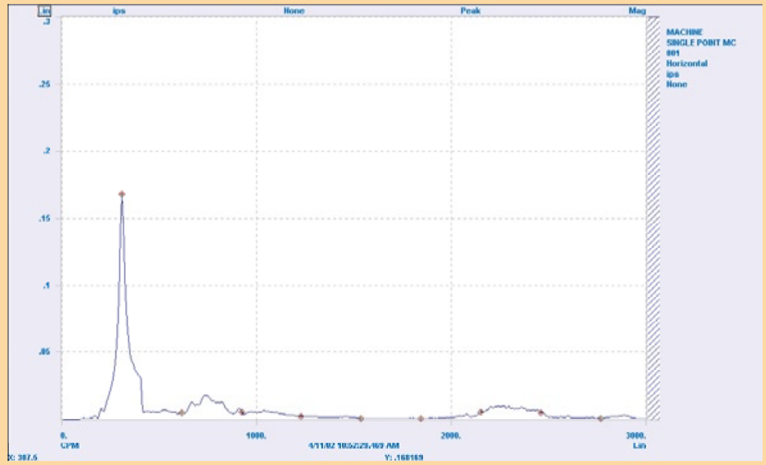


Figure 7 - Peak Averaged Spectra on Large HVAC Fan

How do we measure support stiffness? The measurement requires a two-channel digital signal processor that has the capability to calculate the frequency response function (the ratio of the response motion to the input force excitation). The data is captured as impact data. Most digital signal processors will save all of the data necessary to give the results plotted in Figures 8 and 9.

The measurement in Figure 8 was taken on a large DC motor with a soft support system. The first cursor has been placed on the running speed of the motor (34 Hertz, or 2040 RPM). Figure 8 identifies a natural frequency response at 34 Hertz.

Figure 9 is the dynamic stiffness plot of the same impact test. Most dual channel digital signal processors calculate dynamic stiffness by taking the FRF, double integrating the response and then taking the reciprocal. Most FRF data is taken in accelerance (response acceleration in proportion to the impact energy). The reciprocal of acceleration is apparent stiffness. Remember, it's important to keep the transducer units in order during this process. In this example, acceleration units of inch/sec/sec yields stiffness in lb/inch.

Note that the red trace (horizontal) dips at the running speed peak. This is because the stiffness is actually reduced at a natural frequency, thereby resulting in an increase in the vibration level. The response in the FRF will be a maximum peak and a valley will appear in the dynamic stiffness plot at the same frequency. The stiffness at this natural frequency is 9,536 lb/f (in/sec^2).

One more example: A customer recently sent a 2500 hp, 2-pole sleeve bearing induction motor to a shop for reconditioning. Following the reconditioning work, repair technicians ran the motor at full voltage on their test stand. The test stand foundation consisted of a 6 inch thick steel base imbedded in a sixteen inch concrete floor. The motor was set directly on the steel base with toe clamps grabbing the motor feet and securing them to pre-drilled holes in the steel base. The measured vibration levels on this motor were all well within satisfactory limits and bearing temperatures also stabilized well below stated limits.

The shop sent the motor back to the customer, but shortly thereafter, they received a call from the customer stating that vibration levels were not within tolerance (the motor was uncoupled at the time). Attempts to review a peak hold averaged plot or a properly performed impact spectrum from plant site

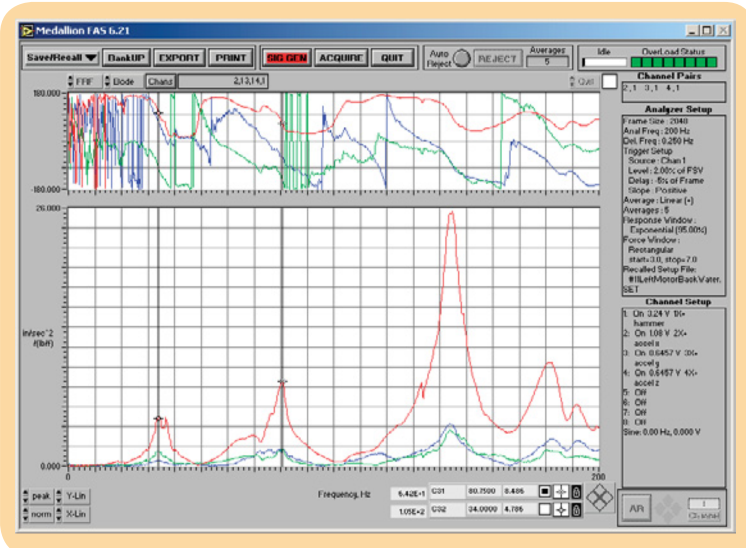


Figure 8 - Frequency Response Function from Impact Test

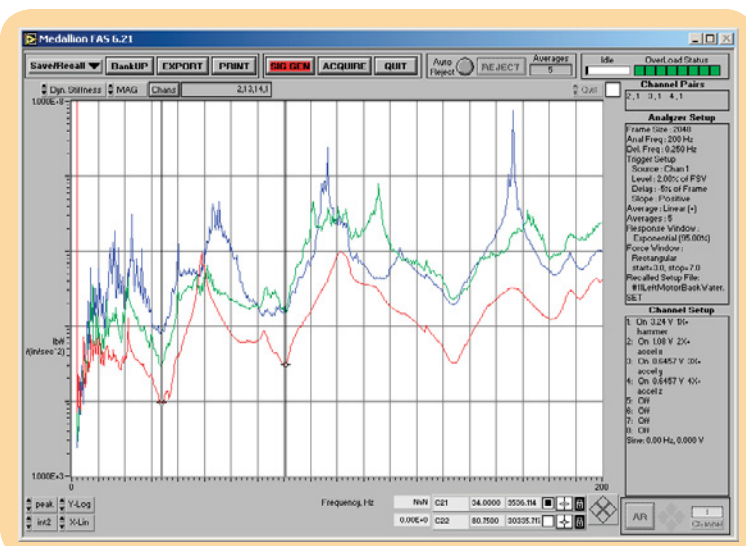


Figure 9 - Dynamic Stiffness

personnel were unsuccessful. The motor was returned to the motor shop as defective.

Testing at the shop again revealed the motor was good. This time, the shop decided to send their field service technician to the customer along with the motor. After several hours on site, it became obvious what was wrong. The motor feet ran the entire length of the motor housing, front to back. The customer had only placed shims at the four corners. The field service tech shimmed the center of each leg and motor vibration dropped to satisfactory limits. Costly? Absolutely. Avoidable? Yes. A learning experience? Hopefully.

So the next time your reconditioned motor demonstrates more vibration than you like to see—and you've eliminated unbalance, misalignment, soft foot and every other possibility—take a look at your support stiffness. What's changed? It could be something as simple as shorter shims instead of shims designed to support the entire motor foot. It could be corroded shims that don't supply full surface support when restacked. Foundations don't last forever. You may want to check for cracks in your concrete foundation or vibration in concrete pads, as this would signify that the fill below the concrete has washed away. The point is you need a complete evaluation of the operating environment, which means taking more data. If the motor had no problems when it came out, but does after reinstallation, it may not be the reconditioning work that's at fault.

Remember—additional vibration data and inspection may be required to isolate the problem. The correct data can isolate the problems and help you resolve these issues before cracks appear in your relationship with the service provider.

Ron Brook is the Manager of Diagnostic Services at the Philadelphia Regional Service Center for Integrated Power Services. Ron is a Level 5 vibration expert with 34 years of vibration experience. His work covers vibration analysis, modal analysis and operating defection shapes, rotor dynamics modeling, vibration isolation and damping, finite element analysis and root cause failure analysis. Ron can be reached at 215-365-1500 or rwbrook@integratedps.com

A Shorcut to Higher Efficiency

Adding Short Repairs to PM's

by Joel Levitt

Short repairs are an excellent way to improve productivity. The reason productivity improves is buried in the details of running any maintenance job, including a PM. Think about the detailed steps that any maintenance worker takes to do any maintenance job. It is quite a list, so let's take a look at the list in Table 1.

Activity
Get job assignment
Obtain Permit
Lock out/tag out
Collect tools
Collect parts, materials
Travel to job with materials and tools (could be a few trips)
Quick safety walk down
Perform work
Clean up work area
Travel back to maintenance shop
Release permit, Unlock, return to operations
Return tools and excess materials
Do paperwork, work order, closing comments

Table 1 - List of activities required to perform a PM.

Notice that there are 13 activities, of which only 1 is productive in meeting your maintenance goals. Most maintenance professionals would agree that each of these activities is essential. They would also agree that as we go through planning, scheduling, training, and maintenance re-engineering, we work to minimize the time for each step.

What is a short repair? In this sense, short repairs refer to repairs that can be done completely and properly in a short time (usually under 60 or 30 minutes) during a PM. Additionally, the repair can be safely completed with the tools and materials that the PM person carries. Short repairs are to be written up for equipment history. The PM person does the job and writes the short repair on the bottom of the PM work order or on a Log Sheet.

Formally, the short repair should be charged to CM (corrective maintenance). If that is impossible because of CMMS inflexibility, then charging the short repair to PM, although less desirable, is still fine.

To facilitate this, equip the PM person (staff maintenance mechanic or contractor) with tools and materials for the most likely short jobs. How do you determine what to carry? Do a Pareto analysis (also known as the 80-20 rule, which states that roughly 80% of the effects come from 20% of the causes) of short repairs, asking the question what are the few repairs that account for 80% of your short repairs? Equip your PM people for those repairs. You can also review the log sheets, have brainstorming sessions on the topic, and, of course, question your old-timers.

Building maintenance departments use a related concept called route maintenance. Route maintenance accumulates short repairs in a building or location. The route person visits each location periodically. You can improve efficiency by scheduling the same location on the same day of the week. The log sheet would be used to record these incidents. The quality of the maintenance department will frequently be judged by the tenant/users on your effectiveness at short repairs.

One thing is clear. If we do a second or third planned job on the same asset, we would add to the "perform work" time. Note that in some plants the scope of work on the permit has to be followed and, if changed, the permit has to be reissued. However, for everyone else an extra job completed at the same time is extremely efficient.

This has been a scheduling trick or tip for years. In fact, a Fleet Maintenance CMMS from the mid-1980s would not only check if there were open items against that unit, it would also see if there were any PMs either due now or that would be due in the next few days. Today when a job is scheduled for a particular asset, the scheduler would have to manually review the backlog for that asset and see if he/she could tag another job along.

One of the best opportunities for these "short repairs" is during unit based PMs. A unit based PM is a typical PM where one machine is PM-ed from top to bottom. The tradesperson goes through all the steps above to complete his/her PM. Readers can step through the times for each activity in their own plant to see if there would be

Activity	Time for a PM	Add a 30 min Short Repair
Get job assignment	10	10
Obtain Permit	40	40
Lock out tag out	20	20
Collect tools	15	15
Collect parts, materials	25	25
Travel to job with materials and tools (could be a few trips)	25	25
Quick safety walk down	10	10
Perform work	**90**	**90 + 30**
Clean up work area	10	15
Travel back to maintenance shop	20	20
Release permit, Unlock, return to operations	15	15
Return tools and excess materials	10	10
Do paperwork, work order, closing comments	10	15
TOTAL	**300 min**	**340 min**

Table 2 - Time required for a PM vs time required to add a short repair.

as much savings in their environment. OK, so let's attempt to answer the question, "What does it take to do a PM on any piece of equipment if the wrench time is 90 minutes?"

In Table 2 we estimate the time each step takes for completion of a PM. Then, in the right hand column, we added time for a 30 minute short repair. As you look over the table, you will see that only a few fields actually increase. We assume that job site cleanup and paperwork both increase slightly. So the result is this:

Let's first look at the ratio of wrench time to all other time for a PM only in Equation 1. Next, we will look at the ratio of wrench time to all other time for PM with short repair in Equation 2.

An improvement from 30% to 35% in wrench time might not seem like much, but it adds up to a 16% (allowing for just a single short repair during a PM) overall improvement. And, it turns out that there are other advantages of having a short repair environment. One advantage that should not be underestimated is that the PM inspectors feel trusted and take greater ownership of the health of the equipment.

$$\frac{\text{Wrench time}}{\text{Total time}} = \frac{90 \text{ minutes}}{300 \text{ minutes}} = 30\%$$

Equation 1 - Wrench time, PM only.

$$\frac{\text{Wrench time}}{\text{Total time}} = \frac{120 \text{ minutes}}{340 \text{ minutes}} = 35\%$$

Equation 2 - Wrench time, PM plus short repair.

There are also several disadvantages to short repairs that should be known and managed:

- The skill requirement for PM people for short repairs is significantly higher than for just PM
- Short repairs require significant judgment (so the short repair doesn't turn into a

long repair or isn't too disruptive)

- One thing that you need to accept is that short repairs cause schedule disruptions

Since we want the PM inspector to be set-up for as many short repairs as possible, we might consider a PM cart. Here is an example of the contents of a PM Cart for building maintenance:

- Hand tools including: (screw driver set, pliers set, claw hammer, cutters, Allen wrenches, vice grips, key hole saw, hack saw, tape measure, utility knife, pipe wrenches, set of files, rasps, good flash light, batteries etc.), stepladder to reach ceiling. Electric tools such as: electric drill and bits, drop light, circular saw

- Cleaning tools (Straw broom, whisk broom, dust pan, trash bags, mop, wring-er, bucket, rags, shovel, sponges, 5 gallon bucket, spray bottles, razor blade scraper, steel wool)

- Cleaning supplies (furniture polish, all-purpose cleaner with TSP, spray deodor-izer, spray tile cleaner, wax, wax applica-tor, wax stripper, toilet bowl cleaner, oven cleaner, metal polish, non-abrasive cleanser), rags, paper towels

- Silicone spray lube, WD40, spray paints, spray zinc, standard off white latex paints (or standard colors) with brushes and roll-ers, joint compound, spackle knife, spackle tape, contact cement, latex and silicone caulk and gun,

- Variety packs of fasteners, variety of nails, small hardware items, duct tape

- Electric: light bulbs (ones you use), flor-escent replacement tubes, switches, outlets, switch, outlet & blank covers, electrical tape, fuses, fittings, outlet tester, neon tester, door hardware, lock sets, door bells, transformers, wire, smoke detectors, batteries, tags for writing dates of installation and testing

- Window hardware, floor and ceiling tiles, threshold and entrance strips

- Bug bombs, insecticide spray, can hornet/wasp killer, roach/ant traps

- Faucet washers and seats (seat tool), kitchen/bathroom faucets with flex lines

- Toilet parts, closet seals, toilet seat parts, closet snake

A cart in a factory would have small spares, tools and other items commonly needed. Different parts of the plant might need different carts.

Adding to the PM Cart

- Each cart or each area has a Cart Inventory list. The cart should always carry these items. It is important that the last daily task is to clean and replenish the cart.

- Study the maintenance log and the corrective work orders. Add items based on jobs requested.

- Periodically meet with the PM crews and discuss jobs completed and jobs that could not be completed. Adjust the cart based on these discussions.

- Allow the individual PM personnel to add things to the cart on their own. Again at the periodic meeting discuss the individual additions to see if they warrant adding to the cart inventory list.

The key to these carts is discipline. The tools and unused materials are put away into the same places, pockets, drawers, and cabinets each time. Care is taken to clean, lubricate, charge batteries, and generally care for the tools every PM day.

In conclusion, Short Repairs are an excellent way to improve productivity and customer service.

Joel Levitt is a leading trainer of maintenance professionals, having trained over 10,000 maintenance leaders from 3000 organizations in 20 countries in over 500 sessions. Since 1980, he has been the President of Springfield Resources, a management consulting firm that services all sized clients on a wide range of maintenance issues. Joel has almost 25 years experience in many facets of maintenance, as a process control designer, source equipment inspector, electrician, field service technician, merchant marine worker, manufacturing manager, and property manager. Prior to that Mr. Levitt worked for a CMMS vendor and in manufacturing management. He is a frequent speaker at maintenance and engineering conferences and has written 6 popular maintenance management texts and chapters of 2 additional reference books. He has also published dozens of articles on the topic. Joel con be reached at 800-242-5656 or jdl@maintrainer.com

Benchmarking a Better Understanding

Benchmarks Shed Light on Maintenance & Reliability Perceptions

by Klaus M. Blache, PhD

Greater reliability is the gateway to improved safety, throughput, quality responsiveness and cost. It can provide competitive advantage for manufacturing, medical, pharmaceutical, utilities, food processing, chemical production, metal forming, assembly, military and many more industries. Understanding what is attainable, knowing how to get there and implementing reliability & maintenance (R&M) best practices can provide that opportunity. This 2008 benchmarking study is a repeat of a similar effort performed in 1991. Specifics regarding 1991 and 2008 comparisons for North America are available from the University of Tennessee - Reliability & Maintainability Center website (www.RMC.utk.edu). For purposes of comparison in this study, the reference "Global" refers to everything except North America (which includes the United States, Canada and Mexico).

The definitions for this study remained the same as the last study.

- Predictive maintenance refers to compiling and analyzing machine condition data to warn of impending failure and identify defective parts (examples include vibration and motor current analysis, infrared thermography, and oil analysis).
- Preventive maintenance uses scheduled routine inspections and improvements to intercept failure (examples are time-based adjustments, replacements, lubrication, and refurbishments).
- Reactive maintenance refers to emergency break downs and related repairs.

Responses were compiled from 217 companies across North America. About 70% of the responses were from manufacturing companies, with the remainder being almost equally split between the remaining categories. The responses were grouped into five categories. Below are examples of the types of companies included in each category.

Manufacturing – automotive stampings (small & large), plastic parts, locomotive parts, machinery, sound systems, conveyor systems, fasteners, ceiling tile, air tools, aircraft, batteries, signs, transmission components, truck accessories and shipping racks.

Assembly – small instruments/equipment, CMM machines, tools, sunroofs, electrical products, automation equipment, automobiles, welding & assembly equipment and automotive components.

Process – steel, chemicals, foods, precious metals and mining.

Distribution – safety products, pumps, instruments, valves, tapes/adhesives, hardware parts and metal products.

Consultants & Other – consultants, hydraulic component repair, tool & die, construction, filtration services, equipment repair services and research & development facilities.

For Global, 75 responses were compiled into one category. Included was participation from Africa, Australia, Austria, Brazil, China, Czech Republic, France, Germany, Hungary, Italy, Peru, Portugal, Spain, Sweden, Switzerland, United Kingdom and more. The companies had an overall mix (types and sizes of companies) similar to North America.

The intent was to collect Actual (current) and Perceived World Class data, two ratios expressed as a percent (Maintenance Expenditure to Original Investment in Machinery and Equipment, and Maintenance Expenditure to Sales Dollars), and several other R&M related questions.

Most of the experts say that about 65% of your Maintenance should be Preventive tasks (15-20% time-based PM's and 45-50% Corrective PM's). The Corrective PM's should be 15-20% resulting from PM checks and 30-35% resulting from Predictive Checks. Predictive Checks should be about 25% and Reactive about 10% (lower is better). So, 65%+25%+10%=100% of your tasks. Note that Figure 1 supports these statements. Look at the Perceived and Actual World Class Percents on the chart in Figure 4 which illustrates these same numbers.

Figure 2 shows that Global companies had 18% Predictive Maintenance work (5% more than North America which is at 13%) resulting in less Reactive Maintenance. Note that in Figure 1, North American companies responded that World Class is about twice what they are doing now in Predictive Maintenance.

Figure 3 suggests that North American companies, on

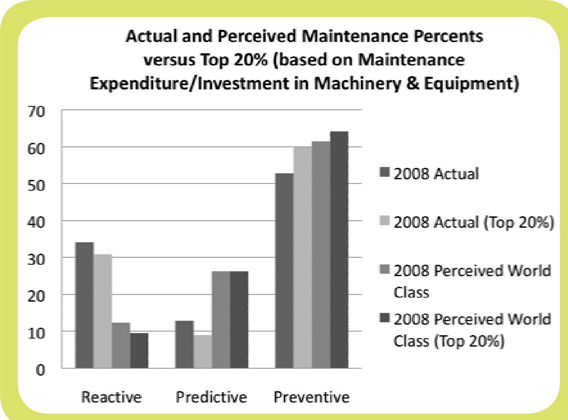


Figure 1 - North American Expenditure by Maintenance Modes

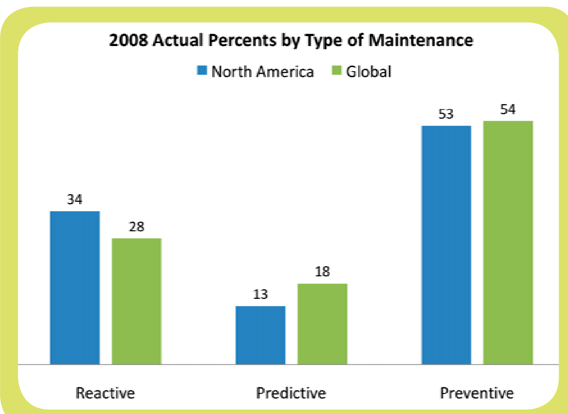


Figure 2 - North American and Global Expenditure by Maintenance Modes

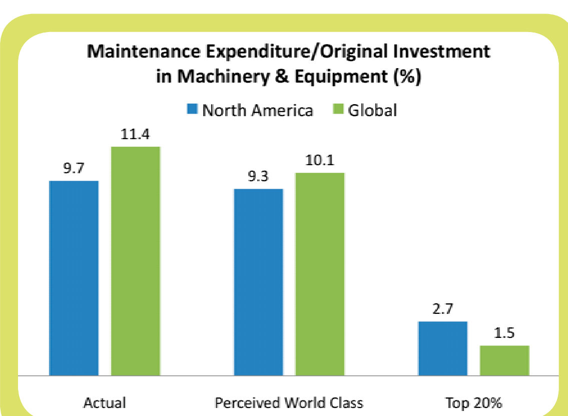


Figure 3 - Maintenance Expenditure as a Percentage of Original Investment

average, do slightly better than Global on Maintenance Expenditure (expressed as a percent of original investment in machinery & equipment). However, when comparing the Top 20% companies, Global does better at 1.5% versus 2.7% for North America.

Proactive Maintenance (100% - Reactive Maintenance) is about 70% and Perceived World Class is about 88% for the Top 20% companies (North America and Global). However, as shown in Figure 4, North America is at 65.9% Actual Proactive Maintenance while Global is at 72.4%. Maintenance Expenditure expressed as a percent of Sales Dollars depicts relatively close values for both North America and Global in Actual and Perceived World Class (all between 4.4% and 4.8%). Note that North America was at 2.4% versus 4.0% for Global, when comparing the Top 20% companies. The 1991 values from a similar study by the author highlights the improvements made over the 17 year period.

Proactive Maintenance and Expenditure Ratios (expressed as %)

* - Everywhere except North America	Year	Location	Actual	Perceived World Class	Actual Top 20%
Proactive Maintenance (100% minus Reactive Maintenance)	1991	North America	45.4	82.4	
	2008	North America	65.9	87.7	69.1
	2008	Global*	72.4	88.1	70.0
Maintenance Expenditure/Original Investment in Machinery & Equipment	1991	North America	15.1	9.4	
	2008	North America	9.7	9.3	2.7
	2008	Global*	11.4	10.1	1.5
Maintenance Expenditure/Sales	1991	North America	5.9	4.4	
	2008	North America	4.4	4.4	2.4
	2008	Global*	4.8	4.5	4.0

Figure 4 - Proactive Maintenance and Expenditure Ratios

Figure 5 is the result of responses to "What major changes do you envision in Reliability & Maintainability in the next 10 years ?". Similar answers were grouped and tallied. The majority of the responses converged on the six categories shown. Here are some observations from the data:

- North America placed People & Cultural Improvements on top with 26% of the responses and More Sensors & Timely Feedback as the sixth category with 6%. The remaining categories of More Design-In Reliability & Maintainability, More Data Driven Processes & Tools (including Predictive), Maintenance Process Improvements, and Specific Maintenance Improvements were in the middle and more closely grouped together.

- Global placed Maintenance Process Improvements on top with 28% of the responses and also More Sensors & Timely Feedback as the sixth category with 5%.

- More Design-In Reliability & Maintainability was the 2nd highest response for both North America and Global. When combining all of the responses (North America & Global) People & Culture are still the highest category, but More Design-In Reliability & Maintainability is very close behind it.

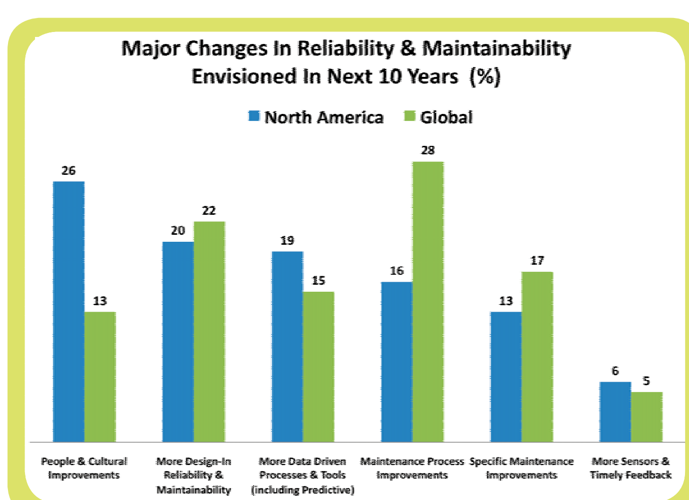


Figure 5 - Perception of Changes in Maintenance and Reliability in the Next Decade

Figures 5.1 to 5.6 provide more detail behind each of the six categories. Within each category, items that North America and Global had

People & Cultural Improvements
(26%) (13%)

- More production operator involvement/ shared goals
- Add/hire full-time Reliability & Maintainability Engineers
- Training (RCM, cross-training, R & M, skills improvement)
- More involvement by all employees
- Improve the culture (management, operator, maintenance)
- Better cooperation with machine suppliers

Figure 5.1

More Design-In Reliability & Maintainability (20%) (22%)

- More design-in reliability & maintainability
- Standardized components/replacement parts on equipment
- Component reliability improvements
- Better use of R & M in decision making
- Standardized controls architecture
- Reduce complexity

Figure 5.2

More Data Driven Processes & Tools
(19%) (15%)

- Better use of Predictive Tools
- Better use of data to drive KPI's/improve processes
- Better integration of SPC and R & M metrics
- Better data on the lifespan of critical components
- Improve OEE
- Better trend analysis

Figure 5.3

Maintenance Process Improvements
(16%) (28%)

- Implement full TPM process
- Dedicated resources for R & M tasks
- Better CMMS use and capability
- Less reactive maintenance
- More timely repairs
- Implement Reliability Centered Maintenance
- More Condition Based Monitoring
- Improve maintenance quality
- Review maintenance frequencies

Figure 5.4

Specific Maintenance Improvements
(13%) (17%)

- Better inventory/spare parts control & local sourcing
- Better lubrication program
- More kaizen events
- More reliable electrical/electronics
- Better system components (i.e., water quality)
- Better handling of critical spare parts
- Better equipment upgrade/replacement schedule
- Improved machine cooling systems

Figure 5.5

Better Sensors & Timely Feedback
(6%) (5%)

- More machine self-monitoring/feedback/ self diagnostics
- More/better error-proofing/prognostics
- Improved sensors & data acquisition
- More equipment troubleshooting/ diagnostics
- More real-time data accessibility & feedback/corrections
- More remote monitoring
- More self-calibration

Figure 5.6

Black = North American and Global responses
Blue = North American response **Green = Global response**

Figures 5.1-5.6 - Major Changes Envisioned in Reliability & Maintainability in Next 10 Years

in common are in black. North America only responses are in blue and Global only responses are in green.

- Note that for People & Cultural Improvements (Figure 5.1), Global wants to focus more on better cooperation with machine suppliers. North America wants to focus more on improving the culture (management, operator, maintenance). The remaining areas listed, such as more production operator involvement and add/hire full-time Reliability & Maintainability Engineers are common to both North America and Global.

- Standardized components/replacement parts, better use of R&M in decision making, and component reliability improvements were frequently mentioned by all (Figure 5.2). For more design-in reliability & maintainability, the Global focus was mainly on maintainability, while the North American focus was on both R&M. North America frequently mentioned standardized controls architecture and Global often referred to reduced complexity.

- Figure 5.3 lists items under More Data Driven Processes & Tools. Both North America and Global often listed better use of Predictive Tools, which is consistent with both of their other responses indicating that not enough Predictive Maintenance is being done. Perceived World Class Predictive Maintenance for North America and Global was at 26.3% and 28.1% respectively. It was interesting that mainly North America mentioned OEE (Overall Equipment Effectiveness) and better data on the lifespan of critical components. Meanwhile, Global mentioned better trend analysis. All mentioned better use of data to drive KPI"s/ improve process and better integration of SPC and R&M metrics.

- Maintenance Process Improvements (Figure 5.4) had varying response themes that were specific to North America and Global. In common was implementing a full TPM process.

- Specific Maintenance Improvements (Figure 5.5) shared the focus on both, better inventory/spare parts control and lubrication program. It was notable that only North America often pointed to more kaizen events.

- Figure 5.6, Better Sensors & Timely Feedback shared similar direction on more machine self-monitoring/feedback, error-proofing and real-time feedback for North America and Global.

Figure 6 is the result of compiled responses to the question "What has positively Impacted maintenance in the last 5 years ?". The high, medium and low responses were

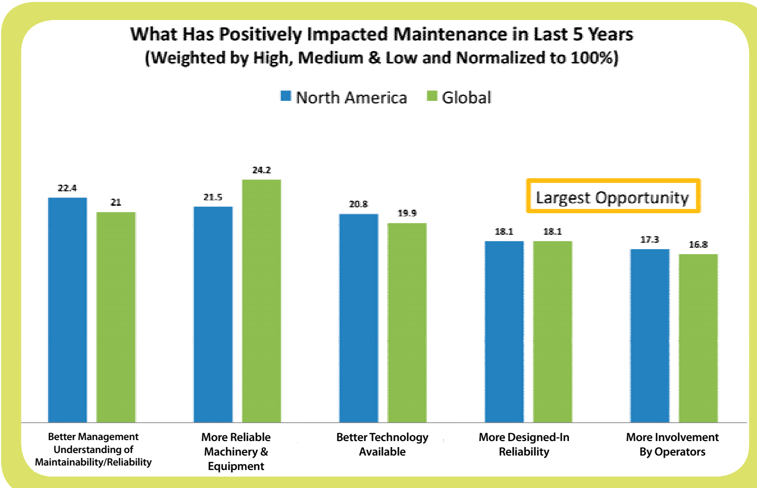


Figure 6 - Positive Impacts to Maintenance in Last Five Years

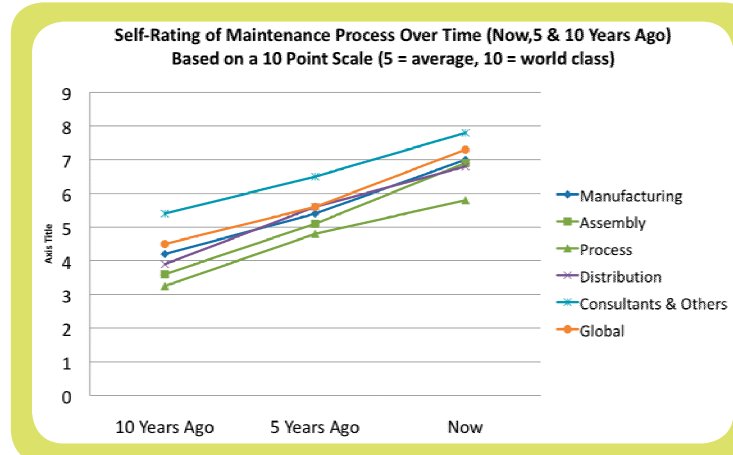


Figure 7 - Self Rating of Maintenance Process

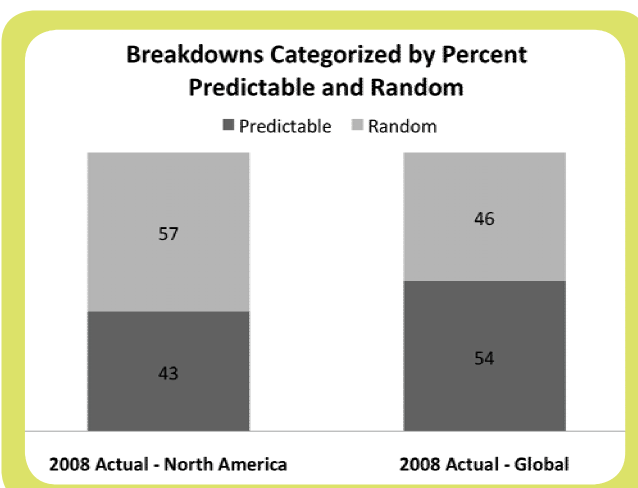


Figure 8 - Predictible vs. Random Breakdowns

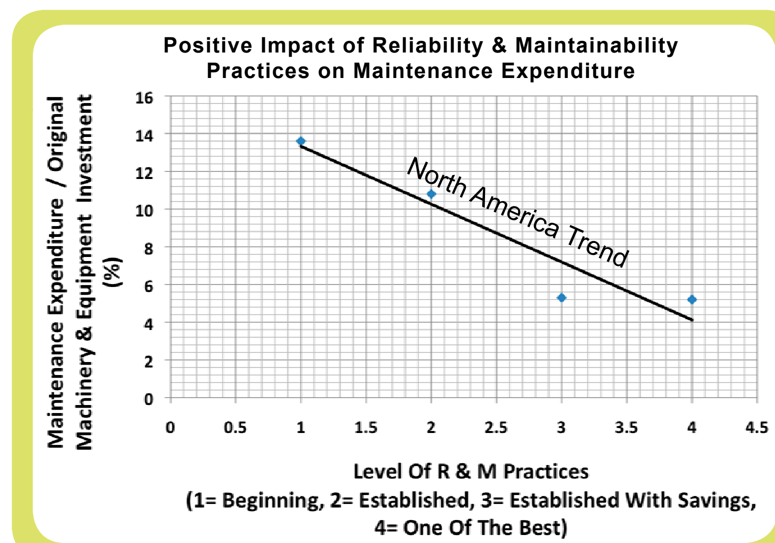


Figure 9 - Realtionship of R & M Practices to Maintenance Expenditure as a % of Original Equipment Investment

weighted and normalized to 100%.

- More Reliable Machinery & Equipment and Better Management Understanding of Maintainability/Reliability were the top two categories for this question, for both North America and Global.
- The two lowest categories were More Designed-In Maintainability and More Involvement by Operators for both North America and Global. These two areas can also be viewed as having the largest opportunity.

Figure 7 is the result of respondents self-rating their Maintenance Process (now, 5 & 10 years ago) on a 10 point scale. This data was further broken down by five Type of Industry categories and Global. This supports the improvements shown from 1991 in Figure 4.

Figure 8 illustrates Breakdowns Categorized by Percent Predictable and Random. It appears that about half of the breakdowns (57% North America, 46% Global) are random or believed to be random.

Figure 9 presents the North American trend of decreasing Maintenance Expenditure/Original Machinery & Equipment Investment with greater Levels of R&M Practices. The area of operation of the Top 20% companies in North America & Global is also shown.

The positive impact of Proactive Maintenance on Maintenance Expense in North America is illustrated in Figure 10. The 1991 and 2008 trend lines of the North America Top 20% companies are provided, along with the Best Companies area for North America and Global. A key message is that most companies are improving, so if your company is not getting better, it's actually falling behind. Plot your Maintenance Expense and Proactive Maintenance and mark that as point A. Then what is it worth going from point A to point B for your plant/company ?

Klaus Blache has over 35 years of experience in various areas of manufacturing and lean. This includes areas such as lean process assessments/improvements, reliability & maintenance, competitive analysis, benchmarking, new facility planning and implementation, industrial engineering, ergonomics/lean medical, and change management. He has written and lectured globally in numerous technical and management areas.

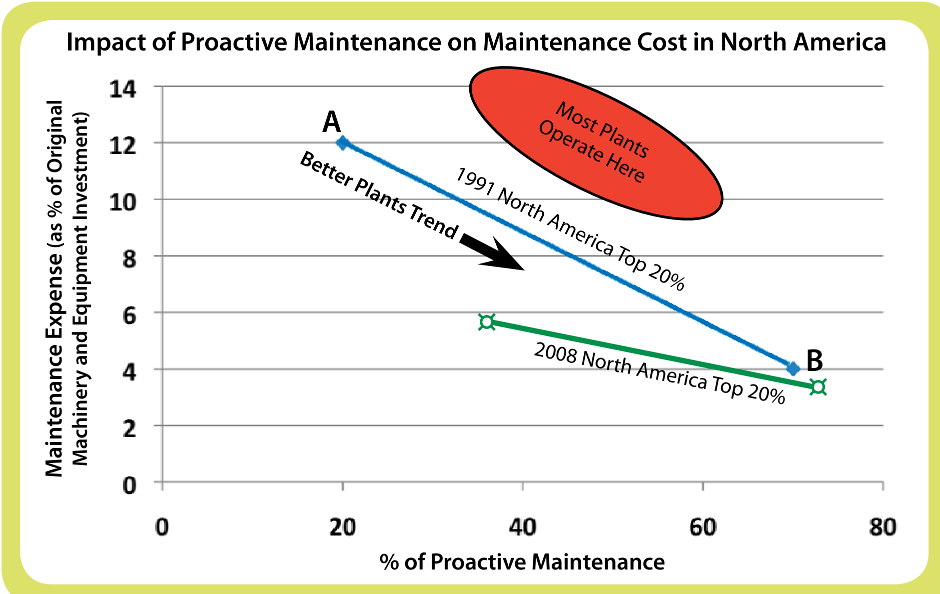


Figure 10 - Impact of Proactive Maintenance Costs on Maintenance Costs
What is it worth to your company to go from A to B ?

His education is a B.S. in Industrial Engineering (General Motors Institute), M.S. in Plant Engineering (Wayne State University), MBA with Strategic Analysis focus (University of Michigan), and Ph.D. in Civil/Mechanical Engineering (Wayne State University). Klaus is currently at the University of Tennessee, Knoxville as the Associate Director of the Reliability & Maintainability Center (www.RMC.utk.edu) and Research Professor (College of Engineering).

His most recent corporate assignments were Manufacturing Engineering Director (design/build/operate new Cadillac assembly plant enabling lean best practices) and Engineering Launch Manager (new SUV assembly plant). He has taught over 200 lean/reliability courses in industry (such as practical problem solving, change methodology, energy management, TPM, workplace standardization, 5S, visual controls/ error proofing, continuous improvement, etc.)

In putting this article together, he called on his background in global benchmarking, implementing a plant-wide lean culture & process, managing the General Motors Corporate Industrial Engineering/Maintenance and Reliability Group and numerous related plant assignments. Klaus is also a past Chairman of SMRP. He is a regular presenter and keynote speaker at conferences. He can be reached at kblache@utk.edu .

Getting (dis)Charged Up

Detecting Corona and Corona Discharge

by Jim Hall with Chuck Humphrey

Picture a thief on a hot, windless summer night, a night that is so hot you might think that you can hear the sound of eggs frying atop a transformer. So hot, that your electrical equipment has maxed out its cooling capacity. It is so hot this thief is robbing you of precious energy, tearing at the very heart of your electrical system. This thief is waiting for that perfect moment to flash over and shut you down, rendering an entire plant or community without power.

This thief is better known to you and me as Corona. How familiar are you with this phenomenon known as corona? Can you recognize corona if you hear it? Can you visually detect the presence of corona? If not, by all means, read on.

Until relatively recent times, corona hadn't been talked about, hadn't been routinely identified, nor readily understood. Here are some of the characteristics of Corona;

- Corona is more prevalent at night.
- Corona is more prevalent during high ambient temperatures.
- Corona is most intense as it moves towards tracking in the 300-400nm range.
- As corona exceeds 400nm, and there is no interference from background light, it may become visible to the human eye.
- Corona is typically responsible for the occurrence of flash over.
- Corona can be heard with the ultrasonic receiver at 1kV or higher.
- Corona is not visible to the infrared spectrum.

Ultraviolet light is a by-product of corona and/or corona discharge. Today corona can be seen in its natural state with the use of corona cameras, which are equipped with special lenses that detect ultraviolet light. Couple that with a video camera and you have a two channel video of the ultraviolet light.

Corona is visible in the ultraviolet spectrum, but can only be found in the infrared spectrum if arcing and tracking have started to occur. So, corona (without arcing and tracking) cannot be seen by the infrared technicians and electrical workers when working under 240kV. However, corona can be heard and detected with an ultrasonic receiver at 1kV or higher. I suggest you build yourself an audio library of electrical wave files to familiarize yourself with nuisance corona, destructive corona, arcing and tracking. Nuisance corona in an outdoor substation, for example, can only be identified with UV camera. In metal clad switchgear, there will be no nuisance corona.

Figure 1 - Inspecting for corona with an ultrasonic receiver and parabolic dish.
Photo courtesy of Ultrasound Technologies, Inc

Corona is nothing new. It was actually identified (along with nearly every other natural phenomenon) by Pliny the Elder in the 1st century A.D. It's often seen atop ship's masts by sailors, including the crews of Magellan and Columbus, and is referred to as "Saint Elmo's Fire". If you happen to drive down a dark highway, especially during a thunderstorm, and observe a blue faint glow atop an electrical line, it will most likely be corona. If you have your AM radio on while driving those same roads, you may hear an egg-frying sound of nuisance corona, usually because of the dirt and dust upon insulators of the power line.

Corona is a continuous decay, and its by-products are nitric acid (or nitric oxide), ozone, carbon and ultraviolet light. Left unchecked, corona will continue to deteriorate insulation values and decay metals until grounding or short circuiting occurs. I have actually seen, due to the effects of corona, the solid core rod of a row of insulators that snapped in two, causing a "line drop."

While researching the detection of corona using airborne ultrasound, I remember seeing the lab technicians apply voltage at 980 to 999 volts, with no detectable ultrasound signature. But, as soon as 1000 volts (1kV) was reached, the frying egg sound of corona could be heard immediately.

I recently sat down with Chuck Humphrey's, President of HighVec, Inc. of Timmins, Ontario, Canada. Chuck has been an avid user of airborne ultrasound for corona inspection for many years. I asked him to share some of his experiences with detecting corona and corona discharge. I told him that for several years now I have been promoting the idea of scanning the switchgear door seams prior to opening, based on the premise that technicians should be able to identify the sounds of corona as well as locate the source.

Chuck told me that he and his crew use ultrasound first to detect the presence of corona. Ultrasound is particularly useful with metal clad switchgear, because with the many cables inside, you may not have line of sight for corona cameras to view corona. Ultrasound receivers can hear the high frequency short wave, which enables the user to locate the corona.

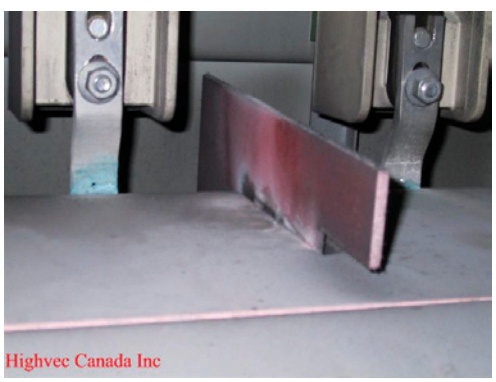


Figure 2 - 13,800 volt switchgear. Poor design. The bakelite divider is tight against the 15kv buss, increasing the electrical stress across all three phases. The green color that you see is corrosion from corona discharge. The black that you see is carbon from corona discharge.

Photo courtesy of HighVec Canada, Inc.

Talking with Chuck about the actual inspection of metal clad equipment, I was most interested in how they approach the gear. He said that his crew "does not" scan the panels with ultrasound before they open the cabinet, that it is a waste of their time. Now this goes against my beliefs, but he went on to explain that his crew is already prepared for whatever is going to happen. They are outfitted in a Category 4, 95 Cal Personal Protective Equipment (PPE) suit (full moon suit).

Chuck also explained how inspecting metal clad gear is like a cat and mouse game. You have to be able to hear it, then locate it, identify the root cause and offer a remedy. Airborne ultrasound detection gives them the ability to find the corona discharge both in the early stages, before any serious damage is done, and in the more advanced stages, but before tracking. The service they provide is all about safety to the worker and eliminating downtime.

Here are some telltale signs of corona:

- The smell of ozone when opening the switchgear (Ozone is a by-product of corona).
- Residue from the nitrogen oxide (white powdery residue).
- Air patterns forming in the contamination.
- Discoloring of areas in the switchgear near or on conductors or buss work.
- Oxidation or corrosion.

Even though Chuck and his crew do not scan the doors before they open them, this should still be standard practice for all technicians and inspectors prior to opening any electrical cabinet. Please remember that Highvec is a company specializing in cleaning and inspecting "hot" substations and metal clad switchgear. You will most likely not be in a Cat 4, 95 Cal suit. So, if you want to live a long and happy life, it would be wise to scan before ever opening any cabinet or door (480v or higher).

Figure 3 - Cat 4, full PPE protection.

Photo courtesy of Brady Infrared Inspections, Inc. Stuart, Florida.

I mistakenly thought that once corona is present, it's there until removed. But Chuck explained that corona may be there today, but gone tomorrow. Moisture, air movement, air quality and heat all have a role in the accumulation of dust and dirt particles that form where corona is present. Opening a cabinet door too quickly can cause enough air movement to change the position or the characteristics of the corona (or eliminate it altogether). Ionization can also create air movement. Air quality can be a problem , not just the ambient air particles but how much air can or cannot

Figure 4 - 2,300 volt cable laying on metal clad. You can see the change in air patterns from the corona discharge.

Photo courtesy of Highvec Canada, Inc.

pass around and between cables of the cabinet structure or hardware (electrical fittings, etc.). The lower the air quality, the higher the chance of corona occurring.

Chuck also cautions anyone that "only" listens to switchgear panels with an ultrasound receiver needs to confirm corona - particularly those technicians that do not find corona while scanning the door seals or openings without opening the doors. Yes, there are technicians out there that will simply stop the inspection if they don't hear corona using the ultrasound receiver. That's simply wrong. You should not rely simply on sound to hear corona. You should always open panels and inspect visually as well, using all the tools available to you today, infrared, corona cameras, etc. Always remember that corona can be present at low amplitudes, yet left unchecked, can and will become a problem later.

Some electricians and inspectors who are not familiar with the proper use of airborne ultrasound have misinterpreted the its application when inspecting for corona. Some believe that if they did not hear or detect corona inside a cabinet while scanning the door seam, then there must not be any corona in the cabinet. Wrong. The practice is to scan the door using your ultrasound receiver placed perpendicular to the door or cabinet door seam or seals. This will help eliminate hearing competing ultrasound or reflected ultrasound from another source or door. If corona is heard, you should make note of the area, and once you are wearing the Personal Protective Equipment (PPE) to be in compliance with the NFPA-70E, you should open the cabinet door/doors "slowly". Once the doors are open you should scan with the ultrasound receiver keeping the instrument from extending into or inside the cabinet door boundaries. Since, ultrasound is very directional, you should be able to locate

Training Guide Listing

Maintenance Planning and Scheduling Workshop by Doc Palmer and Jeff Shiver of People and Processes
January 26–28, 2010
To Register: https://www.ce.unf.edu/CourseStatus.awp?&course=10WWRAM101A

Level 1 Infrared Certification Training by Larry Welch of AIRT
February 1–5, 2010
Time: 9:00 am – 5:00 pm
To Register: http://www.infraredtraining.net/pdf/AIRT%20Course%20Registration%20Form.pdf

Reliability Engineering Fundamentals Workshop by Andy Page of GPAllied
February 9–11, 2010
To Register: www.GPAllied.com or call 888-335-8276

Shaft Alignment with ROTALIGN ULTRA and ROTALIGN PRO by Dennis Onken and Pedro Casanova of Ludeca
Thursday, February 9–12, 2010
Time: 8:30 am – 4:00 pm
To Register: http://www.ludeca.com/training_shaftalignment_4day.php

Level I Dynamic Motor Monitoring/Introduction to DC Motor Monitoring by Scott Lebruska of SKF
February 16–19, 2010
To Register: http://www.skf.com/portal/skf_bak/home/training?contentId=774305&lang=en#

Airborne Ultrasound Certification: Level 1 & 2 by Debra Smith, Gus Velasquez and Thomas Murphy of SDT
2 ½ days (see website for details) • ASNT Certification
To Register: http://sdtnorthamerica.com/training/schedule.htm

Mobius Institute North America – iLearn – iUnderstand – iGrow by Walt Barringer or Alan Friedman
(see website for details)
For Training Options: http://www.mobiusinstitute.com/mi/TrainingUSA.html#CatI
To Register: http://www.mobiusinstitute.com/mi/TrainingUSA.html

Classes on Predictive Maintenance Technologies Available Onsite or in 4 Locations
For more information or to register: Go to www.mhm.assetweb.com

Please log onto www.reliabilityweb.com for more event listings.

the source of the corona. Sometimes an attachment such as a non-conductive cone can be used to aid you in pinpointing the corona. But you should never stop an inspection if you do not hear the corona! A visual inspection may still reveal corona activity.

Chuck likes to use a custom-made, long straw-like cone attached to his ultrasonic instrument that allows him to reach into tight spaces while thoroughly examining a cabinet while the cabinet is energized. CAUTION - *Do not mistake the "long straw-like cone" with the regular rubber cone that comes standard in your ultrasound kit. The straw like cone is a special cone built for this end user only.*

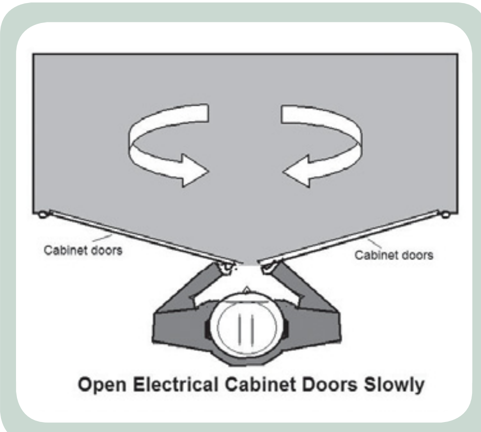


Figure 5 - Opening the Electrical Cabinet Doors Slowly is a good practice to help slow the movement of air inside the cabinet.

Since ultrasound does not require line of sight, you can follow the sound to locate, and to visually identify, the corona or signs of corona discharge. Signs include carbon tracks, a white powdery residue and/or dust and dirt accumulated at the point of the ionization.

Chuck told me that on one occasion they had to enter a cabinet that had smoke coming from the vents. They were able to open the cabinet and subdue the flash over potential using their cleaning equipment without an incident.

Many of you have probably seen some remarkable video clips on youtube.com, where someone has filmed an arc flash or flash over. Now, that's pretty scary stuff. I cannot imagine being inside a cabinet when a flash over occurs, let alone standing there and watching the fireworks as it happens — even if I was wearing a Cat 4, 95 Cal suit!

A digital corona camera may be used in the daytime or at night to detect corona in switchgear and or in a substation. The low light analog type camera is used at night, and will give a view of the corona discharge as it actually fires. Ultraviolet cameras can detect the corona wherever it may exist, which is normally 1,000 volts (1kV).

Chuck performs all substation scans at night and only during the summer months, because the conditions (moisture in the form of snow & ice and low ambient temperatures) in winter months, are less favorable for corona detection. However, he does inspect metal clad switchgear year round.

Why airborne ultrasound? Corona is ionization. The ionized air particles create friction. A disruption of the molecules in the air creates the friction, which, in turn, creates a high frequency sound. Ultrasound is defined as sound above 20 kHz or 20,000 Hz, and most ultrasound receivers are centered at 40 kHz; others may have tunable frequency selectors enabling them to select between 20-200 kHz.

The typical airborne ultrasound detector you use for air leaks, bearing analysis and steam traps diagnostics is the same instrument that can be used to scan your switchgear cabinet for arcing, tracking and corona activity. However, the trick is identifying the sound of nuisance corona, destructive corona, tracking and arcing.

Chuck has many years of experience using airborne ultrasound as part of his cleaning and inspecting of high voltage equipment and substations. He is one of only a few leading authorities that inspects high voltage equipment while HOT.

You may have seen pictures of men in "moon suits" (Category 4 PPE), inspecting high voltage cabinets. But seldom do you see pictures of men like the crews of Highvec inspecting high voltage cabinets with the doors open. This is very dangerous work and only a few will actually perform this work while the equipment is energized.

These men will see more in one inspection and cleaning of high voltage switchgear or apparatus than most will see in a lifetime working at their plant. Highvec's crew are more than just glorified dust and dirt cleaners...they are highly skilled technicians.

Figure 6 - 4,160 volt conductors. Two of them crossing at 90 degrees. This alone, when touching, extremely increases the stress coupled with poor air quality.

Photo courtesy of Highvec Canada, Inc.

My first encounter with this group was at a trade show many years ago while selling airborne ultrasound equipment. This company, and particularly their knowledge regarding locating and understanding the phenomenon known as corona, had greatly impressed me. At that time, I had not come in contact with anyone else who understood what they were seeing, or even what to actually look for, much less how to remedy corona.

Even way back then, Highvec was already inspecting substations at night using analog corona cameras, which were just coming into the marketplace.

Chuck was kind enough to allow me to post a 60-second mpeg video of corona as seen through the ultraviolet camera on my website. Go to www.ultra-soundtech.com to view this truly amazing clip.

Just remember those Fourth of July celebrations where you might have held a sparkler in your hand that was supported by a thin piece of wire. That is what the corona spray reminds me of. Sometimes those little sparks would end up down the collar of my shirt or, fall on my bare feet (southern boy) and burn like heck. Ouch.

Well, just imagine how much trouble you would be in if you were holding, oh, say 100,000 sparklers. That will give you a rough idea of what would happen if you open an electrical cabinet and flash over or an arc flash occurs? One gentleman in one of my Ultrasound Level I classes had, in fact, experienced an arc flash occurrence. Luckily, he happened to be exhaling at that moment, and not inhaling.

I have a personal mission to educate as many technicians as I can about just what is in the switchgear and metal clad cabinets that they cannot see with their own eyes. Today's technicians are learning about infrared and how to use the infrared systems, but few actually have seen the photos, the videos, or have actually viewed this phenomenon with a corona camera.

When I think back a few years, I am amazed at how irresponsibly (although at the time, we didn't know better) we inspected switchgear using airborne ultrasound. I can thank my lucky stars I am still here among the living. I can remember years ago seeing training video clips of instructors reaching through and inside the switchgear cabinet door with an ultrasound instrument. Granted, this was before NFPA-70E, but even then, that should not have been a recommended practice. You should never, at any time, reach inside an electrical cabinet with a metal instrument like an ultrasonic receiver to inspect a connection for arcing, tracking or corona. Always stay outside the perimeter of the door.

I want to thank Chuck Humphrey and the men of Highvec for taking the time to talk to me and provide these photos and information, so that others can benefit from their experience in the detection of corona. As Chuck mentioned earlier, "It's all about safety to the worker and eliminating downtime."

Jim Hall is the president of Ultra-Sound Technologies, a vendor-neutral company providing on-site predictive maintenance consultation and training. UST provides an Associate Level, Level I & II Airborne Ultrasound Certification. Jim is also a regular provider of on-line presentations at ReliabilityWeb.com and is a contributing editor for Uptime Magazine (ultrasound segment). Jim has been in the airborne ultrasound industry for 20 years. Jim has provided airborne ultrasound training for several Fortune 500 Companies in electrical generation, pulp & paper, petro-chemical and transportation (marine, automotive, aerospace). A 17 year civil service veteran, Jim served as an aerospace engineering technician for Naval Aviation Engineering Service Unit (NAESU) and with the Naval Aviation Depot Jacksonville Florida (NADEP). Jim can be reached at jim.hall@ultra-soundtech.com
or *(770) 517-8747*

A Little More About A Unique Electrical Cleaning Process

Chuck Humphrey, President of Highvec Canada is based in Timmins, Ontario, and is central to the Canadian mining industry. They provide a unique cleaning system for power distribution components as well as medium to high voltage inspections. The cleaning process cuts costs by eliminating expensive repairs, minimizing downtime and reducing the possibility of injury.

Highvec Canada, Inc. was launched in 1990 and, since then, has worked extensively across Canada and with some US companies. The highest quality equipment is used by Highvec. In fact, some of their specialized equipment was actually developed to fit the process they use. Highvec's crew members have years of experience using and perfecting their process of cleaning and inspecting medium to high voltage gear. Highvec has adapted its unique cleaning and inspection process to serve a variety of industries; each with their own electrical contamination problems. Industries that they have worked with include: Mining, Smelting, Refineries, Steel Plants and Pulp and Paper Mills.

Grime, grit and dirt can collect on high-voltage electrical equipment, increasing the potential for equipment failure or even life-threatening fires. Cleaning usually means turning off the power and losing productivity and income. Highvec's innovative system cleans your systems online, with no powering down and no downtime. Highvec also provides sophisticated infrared (IR) and ultraviolet (UV) inspection services to spot potential problem areas to save the expense of major repairs.

Finding A Cure

Structural Failures in Vibrating Screeners at a Petrochemical Plant

by Maki Onari and Eric Olson

We were contacted by a leading South American petrochemical facility that had been beleaguered by persistent malfunctions of process machinery. The machinery, large vibrating screeners, had been installed at the plant several years ago. The malfunctions were caused by cracks that occurred along the welds, plates, and beams which comprised the structure of each screener, and occasionally by failures of the suspension cables that supported the screeners. These structural failures rendered the vibrating screeners inoperable, and resulted in lost production of approximately 25 metric Tons/hour per screener. With eight of these massive screeners operating within the facility, and at a salable product cost of $200/ton, the net production losses approached $1 million per day. In addition, the recurring maintenance costs borne by the petrochemical facility were substantial.

The eight screeners were used in the synthetic production of urea from hydrocarbons. Today the primary global demand for urea is as a nitrogen-rich solid fertilizer, but other applications include the manufacture of adhesives and polymers. Near the end of the production process, each vibrating screener was fed a supply of urea pellets through top nozzles that were located near the gearbox end of the sloped hopper of the screener, see Figure 1. The screener was driven by a constant speed induction motor through a gearbox. During operation, an eccentric output shaft on the gearbox of the screener caused the hopper to reciprocate vigorously in the horizontal plane. Mesh screens that were arranged within the shaking hopper enabled the pellets to be graded by size, and the sorted pellets then were discharged from the bottom of the screener. The screener was supported with a fabricated base structure in conjunction with four suspension cables, also Figure 1, to accommodate the motion that occurred during its operation.

Testing

Detailed investigations of two of the eight vibrating screeners were performed at the facility to identify the root cause of the screener failures, and to reach an effective, practical solution to the machinery problem for the customer. While the screeners operated in the typical manner, a multiple channel spectrum analyzer was used to record detailed vibration data from the main structural components of the screener, which included the hopper and the base structure. Operating Deflected Shapes (ODS) of the screener were created from this data to visualize the motion of the screener accurately during its normal manner of operation. A modal impact test of one of the screeners also was conducted to establish the natural frequencies of vibration and the mode shapes of the screener assembly. Because compliant connections facilitated relative motion between the hopper and the support structure, separate sets of impacts were performed on the hopper and on the support structure of the screener. The hopper and the support structure were impacted both horizontally and longitudinally, and the responses were recorded at locations throughout the screener using accelerometers. The representative vibration spectrum of the screener is shown in Figure 2, and the running speed and its harmonics are identified as peaks throughout the frequency spectrum.

In addition, key dimensions of the screener's structure that included the thicknesses of the plates and beam flanges were measured by the customer, to identify any potential deviations from the original design which may have been introduced inadvertently during the fabrication process. All of the measured dimensions were confirmed to have been within the tolerance limits of the dimensions which had been specified on the engineering drawings of the vibrating screener.

Analysis

Simultaneously, a three dimensional (3D) finite element model of the screener, which included the base structure, was created. Drawings of the screener were supplied by the customer, from which 3D solid geometry models were produced (Figure 1) using the Pro/Engineer solid modeling software package. The 3D solid model geometry was translated into the ANSYS finite element analysis (FEA) software environment, where it was distilled into a mesh of elements that represented the mechanical structure of the screener. The appropriate element properties, material properties, and boundary conditions were assigned to the elements in order to create the comprehensive finite element model of the vibrating screener.

The 3D finite element model of the screener was used to conduct a detailed modal analysis that accounted for gravitational acceleration in the vertical direction, along with lateral and longitudinal accelerations which simulated the motion that was induced by the gearbox. The finite element modal analysis predicted the natural frequencies of vibration and the associated vibration mode shapes of the screener. The screener had been designed to segregate pelletized solid material, by size, through the application of periodic motion to the structure. Therefore, the greatest vibration amplitudes occurred at the gearbox output running speed, i.e. 3.56 Hz or 1x running speed (Figure 2), and the bending or twisting modes beyond this rigid body motion were considered in the evaluation of the screener.

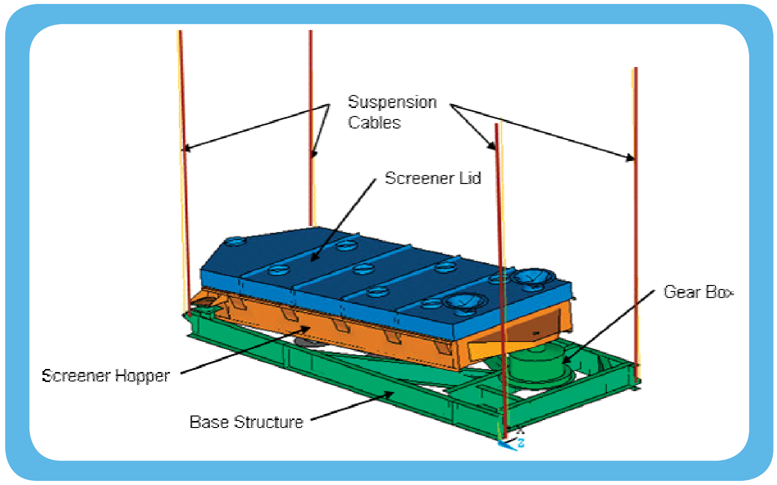


Figure 1 - The solid assembly model of the vibrating screener illustrates the key components of this process machine and how they are interrelated.

Diagnosis

The mode shapes that had been predicted analytically through the FEA were compared with the ODS model, which represented the experimentally-identified mode shapes of the screener. For both the hopper and the base structure, the analytically predicted vibration modes occurred at frequencies that were approximately 1.5 times greater than the vibration modes which had been identified experimentally. The results of the comprehensive modal evaluation indicated that the structural stiffness of the screeners which had been tested at the facility had diminished significantly, to a magnitude that fell well below the analytically predicted stiffness of the nominal design of the vibrating screener.

Using standard equations for the vibration of flat plates, the welded plates that formed the structure of the screener were analyzed to gauge the influence of the edge boundary conditions on the plates' natural frequencies of vibration. Modeling the edges of the plates as clamped boundaries resulted in plate vibration frequencies that matched the FEA model's predictions closely. Modeling the edges as simply-supported boundaries resulted in plate vibration frequencies that fell consistently below those of the experimental modal data. This outcome indicated that the edges of the plates, where the welds were located, had developed increased flexibility over the time which had elapsed since the screeners had been installed at the plant. The response of each plate was characterized by a stiffness that was bounded by those of the simply supported and of the fully clamped edge conditions. Micro-cracks, which had developed gradually in the welded joints, would cause a partial loss of the edge stiffness of each plate, an explanation that was consistent with the findings of the investigation.

The vibration of the plates that made up the screener's structure was found to have had an amplifying effect on most of the vibration modes of the screener, which occurred beyond 4.99 Hz. This was most pronounced at the modes that coincided with the harmonics of the screener's running speed, 3.56 Hz. The plate modes that coincided with the running speed (lower harmonics) and with the first harmonic of the motor speed, 19.16 Hz, proved to be detrimental to the welds throughout the structure of the vibrating screener. Excited by the resonances, the plates responded with enough energy to cause fatigue cracks to develop gradually in the welded zones of the structure. Further, the bending and twisting which occurred during the resonant natural frequency modes of the hopper and the base structure generated a large amount of tension oscillation in the support cables. This action promoted fatigue and the eventual failure of some of the cables to take place.

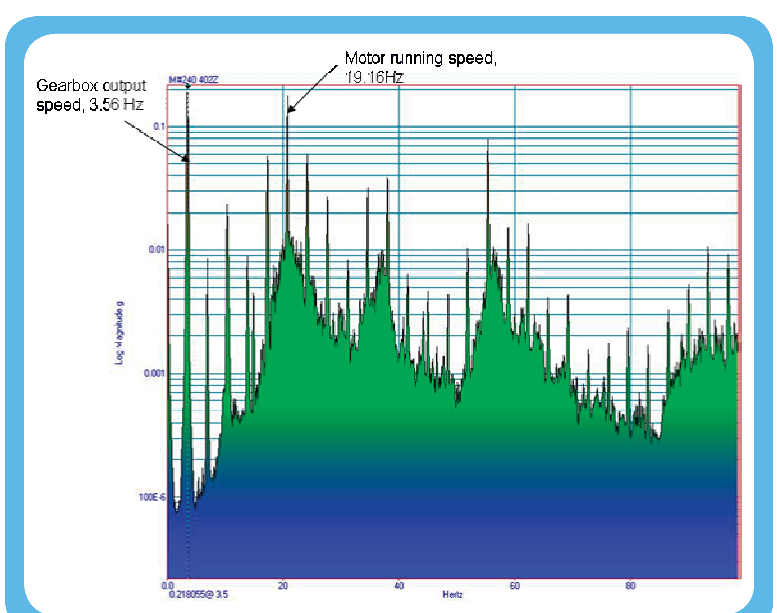


Figure 2 - The typical vibration response spectrum of the operating vibrating screener, which was measured on the right side of the structure near the header and in the axial direction, and prior to the implementation of any of the recommended modifications. The most pronounced resonant peaks represent the gearbox output running speed and the motor running speed.

In addition, a quasi-static finite element stress analysis was conducted to predict the steady-state operating response of the screener's structure while it was loaded by the transient mass of the pelletized solid product. The customer had supplied the approximate pellet loads that typically occurred at key portions of the structure during the operation of the screener. Within the finite element model of the screener, the pellet loads were simulated and a quasi-static FEA was performed to predict the response of the structure to the loads. The results of the FEA indicated that the transient mass caused relatively low stresses to occur at the key locations of the structure, which included the support lugs and the coupling between the gearbox and the hopper's main header.

Also considered was the worst-case net impact loading that was created by the loss of momentum that occurred as the pelletized product fell into the hopper of the screener. Calculations showed that when integrated over the entire hopper, the net magnitude of only the pellet impacts would exceed the steady-state gravity load of the filled hopper if the average impact duration was less than one millisecond. In view of the low modulus of elasticity of the product, the loss of momentum would require more than one millisecond. Therefore, the rate of momentum transfer of the pellets would not create excessive forces on the plates of the hopper.

These additional analytical findings implied that the sympathetic resonances between the lower frequency modes and the harmonics of running speed created the high stresses in the structure, and not the steady loads that were produced as the pelletized product was being processed. Therefore, the excessive mechanical stresses in the vibrating structure of the screener caused the cracks in the welds to develop over time.

Solution

To solve the problem of the failing vibrating screeners, it was recommended that any existing cracks in the main welded joints of the structure should be repaired immediately, both to restore the overall structural stiffness of the screener to approximately that of the theoretical design, and to prevent additional potential failures from occurring that would have been caused by the weakened joints.

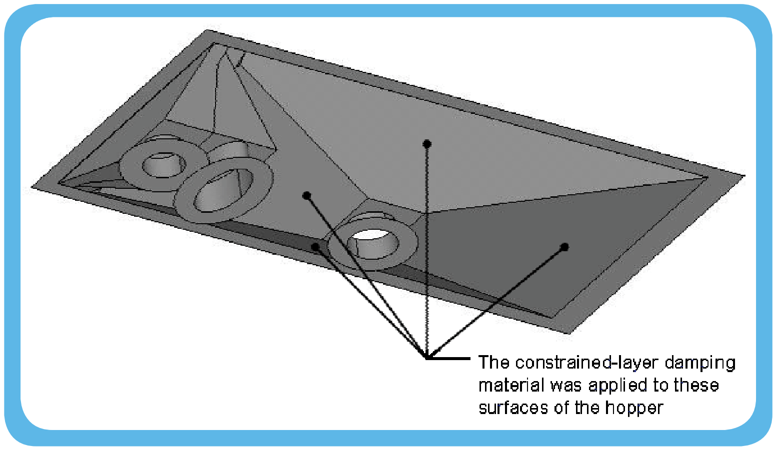


Figure 3 - The addition of commercially available constrained-layer damping material to the surfaces of the large panels of the screener's hopper diminished the plate-mode vibration response of the structure during the screener's operation.

In addition, damping of the plate modes of the structure was recommended to reduce the amplification factor, and hence, the detrimental vibration response of the screener. This was implemented in a practical manner by the application of commercially available constrained-layer damping material to the panels of the screener's hopper (Figure 3).

To improve the service life of the structural beams and the support cables, it was recommended that the twisting and bending mode frequencies of the screener should be increased, to shift them further away from the driving frequencies of the vibrating screener and their harmonics. The welding of strategically-located horizontal ribs along the main beams of the screener's structure was suggested as the most effective means to implement this enhancement of the screener's structural stiffness (Figure 4). The reinstallation of the aluminum lid of the hopper with a thinner than was originally supplied rubber gasket, the addition of support bolts to the corners of the lid, and the retightening of the lid's hold-down clamps were practical supplementary steps that also were suggested to shift the vibration frequencies of the screener upward.

Once implemented, these key modifications increased the operational life of the vibrating screener dramatically by eliminating the frequent failures of the structural beams, plates, and hanger cables which had made the screeners at the plant unreliable. This action eliminated the large production losses that had beset the petrochemical facility, which contributed immediately to the facility's profitability.

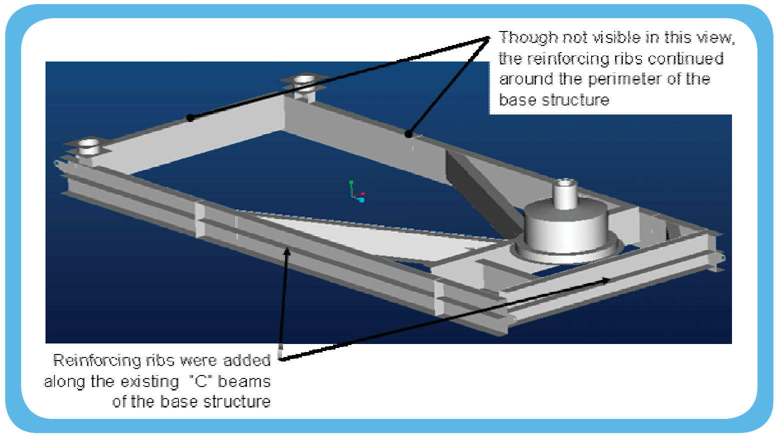


Figure 4 - The base structure of the screener was stiffened by the addition of ribs to the C-shaped structural beams that comprised the perimeter members of the base.

Maki Onari, Manager of Turbomachinery Testing, supervises and performs Mechanical Solutions, Inc's on-site rotating machinery testing projects. Proficient in all of MSI's analysis and testing tools, he has also conducted and directed a variety of finite element analysis projects. His professional career of over thirteen years includes diverse petrochemical experience, and he has performed rotating machinery analysis, diagnosis, troubleshooting, and failure studies on steam turbines, gas turbines, centrifugal compressors, pumps, generators, motors, centrifugal dryers, and fans. Through these efforts he has acquired significant test-stand and field evaluation know-how, and he also has participated in vendor selection/coordination, machinery specification preparation, witness acceptance tests, and machinery commissioning. Maki possesses hands-on experience in the assembly, disassembly, installation, and maintenance of large machines. He is a member of ASME and the ISO TC108/S2 Standards Committee for Machinery Vibration, and has lectured at the Texas A&M Symposia.

Eric Olson, Principal Engineer with Mechanical Solutions, Inc, is a recognized leader in the turbomachinery industry with over 25 years of experience, and functions in both technical and business development capacities at MSI. His extensive background includes the design and analysis of centrifugal pumps and compressors, gas and steam turbines, and air dynamometers for the evaluation of turboshaft gas turbines. He also possesses hands-on field engineering experience with high-performance engineered pumps and other rotating machinery. In prior positions Eric and his staff established a turbomachinery design and development business, and he was a Regional Manager with the responsibility for all parts, repairs, and revamps of large industrial pumps in the western half of North America. A multi-year short course speaker at the Texas A&M International Pump Symposium, Eric is a member of ASME, AIAA and, the Vibration Institute, and he is a Standards Partner with the Hydraulic Institute. Mr. Olson's current areas of focus include turbomachinery troubleshooting, turbomachinery design and analysis, and alternative energy.

Imagine going from having no vibration analysis program to having a fully functional program with top notch vibration analysts interpreting your vibration data and correctly diagnosing your equipment's problems. Now imagine making this transition in a matter of weeks instead of years. Imagine...

vbRemote

Detecting mechanical problems at an early stage has enormous economic advantages. Commtest has now opened that opportunity to companies that either do not currently have a vibration program or have one that is not performing up to expectation for any number of reasons.

The beauty of vbRemote is that you can collect vibration data and have it analyzed be a team of vibration experts, who will then return a report with not only the analysis, but recommendations on how to correct any issues that the analysis finds.

Commtest's Director of Customer Success, Mike Howard who is a Level II Vibration Analyst and CMRP, took some time to give us more insight into this new, and quite unique, remote vibration analysis program. We think this flexible and scalable program could provide valuable benefits, namely fewer failures leading to increased reliability, for a large number of companies. It could be worth your while to take a closer look.

Professional analysts provide proven vibration analysis, condition monitoring, diagnostics, trending, reporting, and effective results. You can utilize vbRemote as part of your predictive maintenance program to decrease maintenance costs, increase availability and increase profits.

Let's start with you giving us a brief overview of vbRemote™.

We developed vbRemote exclusively for Commtest customers as a simple, yet state-of-the-art approach. vbRemote is an economical and professional choice for achieving world class bottom line vibration analysis results.

Through this program of remote analysis, delivered via the internet, select expert analysts provide customers with proven diagnostics, condition monitoring, trending, and other valuable reports, which not only identify defects, but recommend specific corrective action. vbRemote truly focuses on the root cause of the problem, not just eliminating a defect.

With 24/7 online access vbRemote empowers you to take action, reduce costs, maximize productivity, and increase profits.

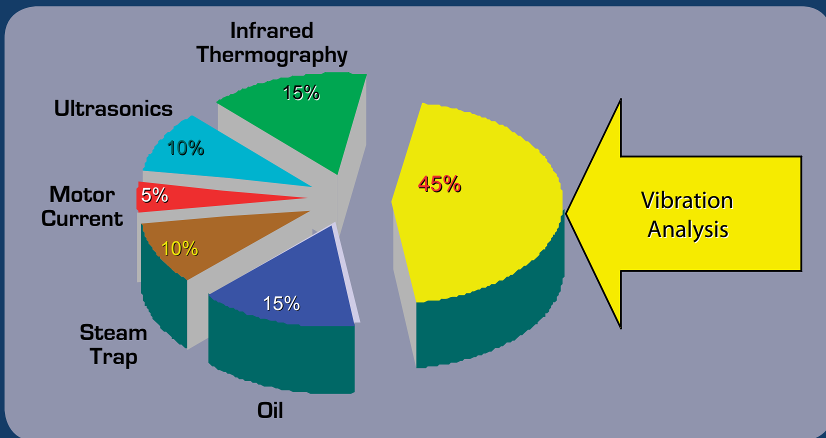
Give us an idea of what types of operations or facilities are a good fit for vbRemote.

OK, first let's think about these questions...

Downsizing, retirements or lack of skilled analysts sound familiar? Does having expert analysts as a back-up to your team seem like a good idea? Not enough hours in the day? Can't monitor everything you need to?

If these questions make you go hmmm...and you can answer yes to any one of them, then vbRemote is probably the right service for you.

Because of it's scalable deployment architecture, vbRemote is uniquely capable of delivering exceptional results for most any oper-



As shown above, Vibration Analysis is the deployed most widely of all the predictive technologies. It offers an extremely high potential return on investment.

ation or facility. Whether serving as the primary vibration analysis program tool, a staff augmentation tool, or as a staff mentoring and development tool, vbRemote really is a natural choice for the Commtest customer.

What do you think the advantages are of using vbRemote instead of a more traditional vibration analysis product?

Unlike traditional vibration analysis products that require some level of training and ramp up time, vbRemote is capable of providing a nearly immediate positive bottom line impact. The Commtest Customer Success Team, who are all experts in the field of Vibration Analysis and Reliability & Maintenance, is able to accelerate your program's impact with quantifiable results.

To take it a step further, vbRemote is able to serve as a long term analysis solution, to augment where internal staff is unable to cover critical assets in need of regular monitoring, and even assist as a mentoring tool to accelerate your staffs eventual internalization of the vibration analysis program.

Are there any cons to using a remote analysis service?

Remote vibration analysis in general does have challenges. One key element of a successful maintenance and reliability initiative is having those with intimate knowledge of your facilities critical assets taking personal ownership of the critical assets. Many remote analysis products limit, or even try to eliminate that intimate knowledge component.

The Commtest Customer Success team recognizes that intimate knowledge is invaluable, and thus has built the vbRemote product with critical feedback mechanisms that enable front line plant employees the ability to actively communicate with the vbRemote staff regarding monitored asset knowledge, such as pm tasks completed, process changes and equipment repairs or replacement.

This feedback mechanism, combined with regular telephone, email and onsite discussions go beyond that of the typical remote analysis product and ensure a true partnership is fostered. This unique relationship makes the Commtest Customer Success team an integral part of your Reliability and Maintenance initiative.

What are the three top reasons a company should consider investing in vbRemote?

1. *Economic & Affordable (Front end Value)*
2. *Trusted, Dependable, and Actionable (Dependable)*
3. *Value to the bottom line via improved asset reliability (Long-Term Value)*

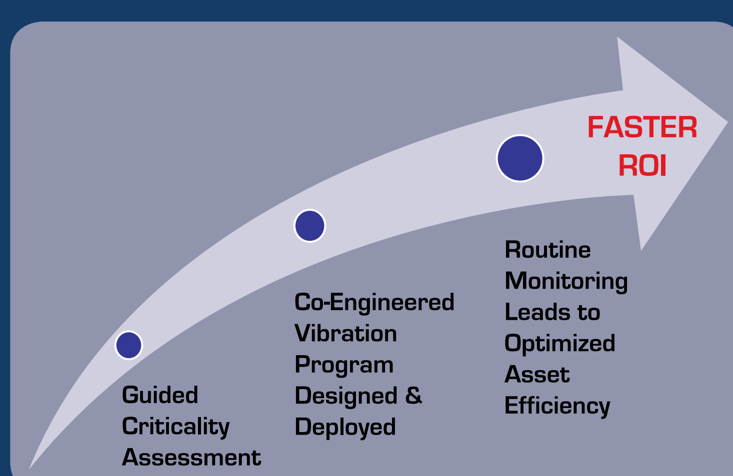
How quickly can a company expect for a return on their investment in vbRemote?

As I mentioned earlier, the vbRemote service is able to provide nearly immediate results that have a positive impact on the bottom line, so long as recommended corrective actions are executed upon.

This is a very new service, so why don't you give us a scenario that would be considered a success story for a company that moves to using vbRemote?

A great example of a success story is a small to mid-size company that in the past could never justify getting into a vibration analysis program because of initial costs, and lack of dedicated resources.

Because vbRemote has such a low cost of entry, the customer is able to realize the benefits of a bottom line focused, well designed, well implemented, proactive vibration analysis program with little to no capital investment required.



Commtest's vbRemote service can allow your vibration analysis program to start identifying problems and the actions needed to correct them, much quicker than a traditional vibration analysis program.

The key here is that the vbRemote is completely scalable and able to meet the needs of most all customers.

How can interested people get more information about your Commtest's vbRemote?

Anybody interested in learning more about vbRemote can visit our website at:
www.commtest.com/cst/vbremote
or www.vbremote.com
They can also call us at:
877 582-2946 (option 1)
or e-mail us at:
vbremote@commtest.com

SHAFTALIGN Redefining Shaft/Coupling Alignment

Precision Shaft Alignment made easier than ever before! SHAFTALIGN's intuitive Auto-Flow functionality guides the operator automatically through the 3 easy steps needed to determine the machinery alignment condition: Dimensions - Measure - Results.

http://www.ludeca.com/prod_shaftalign.php

LUDECA, INC.
ALIGNMENT * VIBRATION * BALANCING
305-591-8935
info@ludeca.com

New 6000 Series DAQ Modules for Temperature and Voltage

IOtech has released three new data acquisition modules in the 6000 Series of Advanced Measurement Products. These products combine high- performance, Ethernet-based DAQ modules with powerful, easy-to-use software. The 6222 is a 12-channel, simultaneously sampled, thermocouple input module. It features 24-bit resolution, for accurate temperature measurements. The 6230 and 6231 are 12-channel, high-speed, isolated voltage input modules. Also included with each 6000 Series module is Encore interactive measurement software, which combines an intuitive user interface with robust functionality.

www.iotech.com 440-439-409

sales@iotech.com

Blue Light LED Flashlight Safe for NDT Inspection

Spectronics Corporation has introduced the OPTIMAX™ 450 — a cordless, high-intensity blue light (450 nm) LED flashlight. It provides a safe, effective tive alternative to prolonged use of UV-A black light. Blue light is perfect for quick pre-inspection or screening of fluorescent particles in operating conditions with ambient light. The OPTIMAX 450 produces a nominal steady-state 450 nm intensity of 7,000 μW/cm^2 at 15 inches (38 cm). "Instant-on" operation allows the flashlight to reach full intensity immediately. The LED lifetime is 50,000 hours and maintains high intensity between charges.

Spectronics 1-800-274-8888 Outside U.S./Canada 516-333-4840
www.spectroline.com

New Low-Foaming Multan Bio-Resistant Metal Removal Lubricants

Henkel Corporation has introduced two new water-soluble Multan metal removal lubricants formulated to generate minimal foam and be used continuously for years with minimal biological degradation. Excessive foam, common when traditional metal cutting fluids are used, causes lubricant overflow and waste while bacteria growth generates odors, degrades the lubricant, and can cause operator health and safety concerns. Both Multan B 236 and B 414 are semi-synthetic metal removal fluids for machining and grinding ferrous and non-ferrous alloys. These lubricants are designed for applications where soft water or process requirements make foam control difficult.

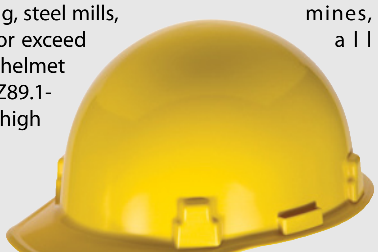
More Info: 248-583-9300 henkel.metalworking@us.henkel.com
http://www.henkelna.com/multan.

Endevco Debuts Ultra Low-Noise Remote Charge Converter

Endevco Corporation has announced the launch of new model 2771C-XX, an ultra-low noise remote charge converter (RCC), designed for use with charge output piezoelectric sensors within mechanical system health monitoring, nuclear power plant/regenerative energy and environmental testing applications. Model 2771C-XX offers a rugged two-wire (IEPE), single ended design that operates from constant current power (4-20 mA). Both RCC signal output and current to the RCC are carried along the same wire. Housed in a rugged, small package, the charge converter offers broadband noise range down to 5μ Vrms, with a frequency response of 0.4 to 50 kHz. Units are designed to withstand shock loads of up to 100g peak, and are radiation tested to 1.0 Mrads.

www.endevco.com

MSA's Thermal-E™ Protective Caps) Offer High-Temperature Head Protection



Pittsburgh, PA –– New Thermal-E Caps from MSA provide head protection for high temperature, electrical/high-voltage, and other dielectric applications requiring NFPA 70E-2009 compliance. Lightweight, durable, slotted caps are ideal for use in utility work, welding, steel mills, mines, and foundries. Thermal-E Caps meet or exceed all applicable requirements for a Type I helmet (top-impact) as outlined in ANSI/ISEA Z89.1-2009, 94.1-2005 (Class E, electrical/high voltage) and NFPA 70E-2009.

MSA 1-800-MSA-2222 www.msanet.com

Accurate gearbox-to-generator shaft alignment made easy with OPTALIGN SMART WIND

LUDECA introduces the OPTALIGN SMART WIND system for the wind power industry. The OPTALIGN SMART WIND is specially configured with firmware features that ensure high measurement accuracy and with mounting hardware that is ideally suited for optimal alignment of the gearbox and generator shafts in wind turbines. No matter the manufacturer, coupling or turbine type, OPTALIGN SMART WIND makes generator-to-gearbox alignment inside any nacelle easy. This safeguards reliability and optimizes the energy efficiency of the wind turbine. Good alignment reduces bearing failure, coupling wear, noise and vibration. Keep the blades turning with LUDECAwind.

http://www.ludeca.com/prod_optaligsmart_wind.php

LUDECA, INC. 305-591-8935
ALIGNMENT * VIBRATION * BALANCING info@ludeca.com

NEW ERGONOMIC LOCTITE(R) 50 ml TUBE SQUEEZE DISPENSER

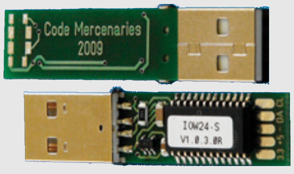
Allows Controlled Positioning of Anaerobic Adhesives and Reduces Material Waste

For dispensing anaerobic flange and gasket sealants in 50 ml tubes, Henkel Corporation has introduced the Loctite(R) 50 ml Tube Squeeze Dispenser, an easy-to-use, trigger-controlled dispense gun that provides smooth and consistent adhesive flow. The ergonomic Loctite(R) 50 ml Tube Squeeze Dispenser eliminates tube squeezing and provides controlled adhesive positioning. This manual dispenser completely empties the tube, reducing adhesive waste and saving material costs. An easy-to-open, pivoting tray makes tube changeover fast and easy.

1-800-LOCTITE (562-8483) www.equipment.loctite.com

Saelig Debuts Dongle for Economical USB to I2C Connection with No Software Driver Requirements

Saelig Company, Inc. has announced the availability of model IOW24-DG, a USB to I2C Dongle offering a simple, easy to use, economical solution for connecting with I2C devices via USB port. Connecting sensors, service interfaces, test and evaluation circuits and other applications can be easily accommodated with the IOW24-DG I2C dongle. The I2C master interface operates at 100 kHz and allows a throughput of up to 750 bytes/s. Handshaking via clock stretching is supported, as well as a programmable time-out function, to prevent the dongle from hanging up due to malfunctioning slave devices. 5V and 3.3V outputs are also available to power small external circuits, such as ambient sensors. The mechanical dimensions prevent the dongle from blocking adjacent ports.



Saelig 888-7SAELIG
info@saelig.com www.saelig.com

Third BOMI Course Gets Approval from USGBC Proving BOMI's Commitment to Energy Efficiency

Jeffrey A. Horn, president and CEO of BOMI (Building Owners and Managers Institute) International, has announced that the U.S. Green Building Council (USGBC) has approved BOMI's Design, Operation, and Maintenance of Building Systems, Part II (Design II) course. This is the third BOMI class that USGBC has approved in the past two months. As an approved USGBC Education Provider, BOMI is a third-party organization that offers peer-reviewed classes accepted by USGBC for their credentialing maintenance requirements. Design II underwent a rigorous review process in which a team of subject matter experts evaluated the course based on its content and instructional design quality.

The other BOMI courses that have received USGBC approval are The Design, Operation, and Maintenance of Building Systems, Part I and Energy Management and Controls. The Design II provides information that property and facility managers need in order to make management decisions about various building systems and sites. Making these decisions correctly will increase occupant safety and comfort while facilitating building efficiency to meet the business goals of an organization.

Each course that USGBC approves has been thoroughly evaluated by a team of three trained, third-party reviewers, according to a USGBC spokesman. Because of USGBC's status as an approved Education Reviewing Body (ERB) for the Green Building Certification Institute (GBCI), all approved courses—including BOMI's Energy Management and Controls and The Design, Operation, and Maintenance of Building Systems, Part I and Part II—will be assigned GBCI Continuing Education (CE) hours, which will help Leadership in Energy and Environmental Design (LEED®) Professionals satisfy their credentialing maintenance requirements.

GBCI launched the LEED Professional Credentialing Maintenance Program (CMP) on August 3, 2009. The program requires LEED Professionals to maintain their credentials by staying current and relevant in a constantly transitioning marketplace. They will be able to satisfy a portion of the credentialing maintenance requirements by attending the designated BOMI classes. Currently, there are over 130,000 LEED Credentialed Professionals in the United States.

BOMI 800-235-2664 www.bomi.org

Company	Page
All Test Pro	pg 35
Allied Reliability	pg 16
AMP	pg 28
ARC	pg 7
ARMS	pg 38
Asset Perofrmance Group	pg 1
Azima/DLI	pg 14
Baker	pg 29
Commtest	Inside Cover
CTC	pg 2-3
Des Case	pg 65
Digital Plant 2010	pg 46
Easy Laser	pg 43
GPAllied	pg 59
Hawk IR	pg 27
iLearn/Mobius	pg 58
IRISS	Back Cover
Lubrication Engineers	pg 10
Ludeca	pg 25
MARCON 2010	pg 42
MRO-Zone Bookstore	pg 41, 49
Philadelphia Mixing Solutions	pg 12
Reliability Performance Institute	pg 4
Reliability Training Guide	pg 52
Sachs, Salvaterra & Associates	pg 54
SAP Center.com	pg 17
SDT	pg 55
SKF/Baker	pg 39
UE Systems	pg 33
Vibration Institute	pg 31, 53
Wilcoxon	pg 33
Webinar Guide	pg 34