Explosion-Proof Vacuum   Boiler Soot Blowing Audit   Wind Power

February 2009

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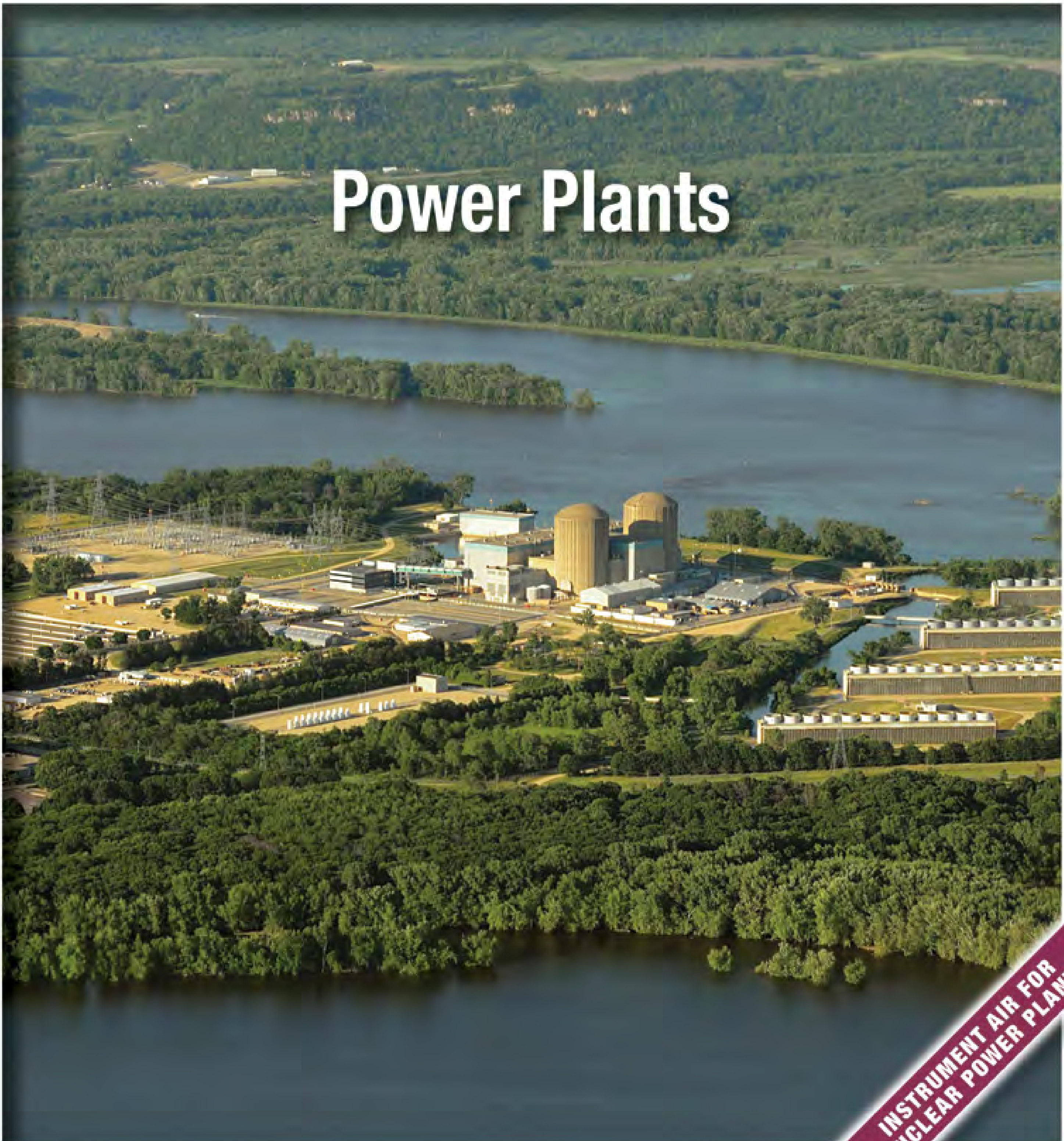

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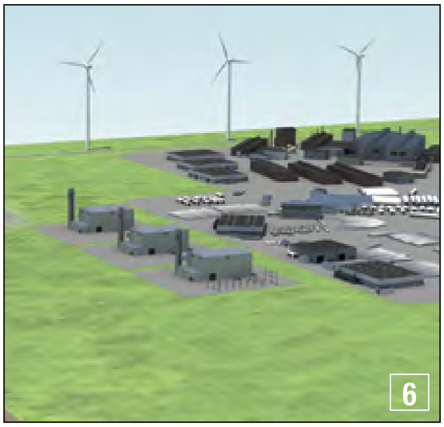
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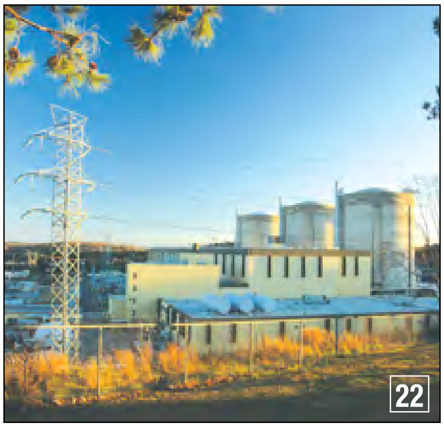
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COMPRESSED AIR INDUSTRY ARTICLES

FROM THE EDITOR

Power Plants

This edition was one I found fascinating to put together. Obviously, the power industry is going through a transformational period as the U.S. tries to figure out whether to be a leader or a follower in the "green industry" of the future. I'm yet to hear a rational discussion on what the "mix" should be. Instead, we just hear people promoting what they have invested in.

Fossil fuel plants using coal continue to be the main power source in the U.S. In the January "Audit of the Month," Mr. Hank Van Ormer provides us insights on how to roll up your sleeves and save by implementing, "Boiler Soot Blowing Best Practices." This particular audit saved his customer $1.4 million per year in compressed air-related energy costs! The idea at this power plant was that if you are consuming too much energy — you aren't selling it!

"Best Practices" does not always mean saving energy. In the case of the nuclear power industry, Mr. Bill Eister writes about how CANUG (Compressed Air Nuclear Users Group) has been ensuring high-quality instrument air for it's members for many years. This "users group" shares information amongst Compressed Air System Engineers in nuclear facilities to help ensure safety and quality compressed air. I can think of some other industries that would really benefit from a "users group" like this!

This fossil fuel plant saved $1.4 million per year in energy costs

Power plants have had to stiffen their security measures since 9/11, and explosion-proof vacuum systems have become a necessity. Mr. Paul Miller, from Nilfisk CFM, shares a tutorial on the topic with us in this edition.

We include the second installment from Mr. Thomas Mort on the "Seven Sustainability Projects." This month he writes about Demand Control. It is so interesting to see the low-hanging fruit, which factories can reach by running machinery at times which allow them to save money (without disrupting production schedules).

Finally, we include an article in our "Personal Productivity" section which talk about why the strategies of some leaders fail — particularly growth strategies. Mr. John Baker talks about how the key is in execution, where failure can doom many sound strategies. My favorite strategy in "soft markets" is market share attainment. Please email me if you'd like to discuss this. I have found in my career that it is in markets like this that the biggest market share changes can be attained.

Thank you again for your support and for investing in industrial energy efficiency.

ROD SMITH
Editor
rod@airbestpractices.com

UTILITY-AIR NEWS

Image courtesy of General Compression

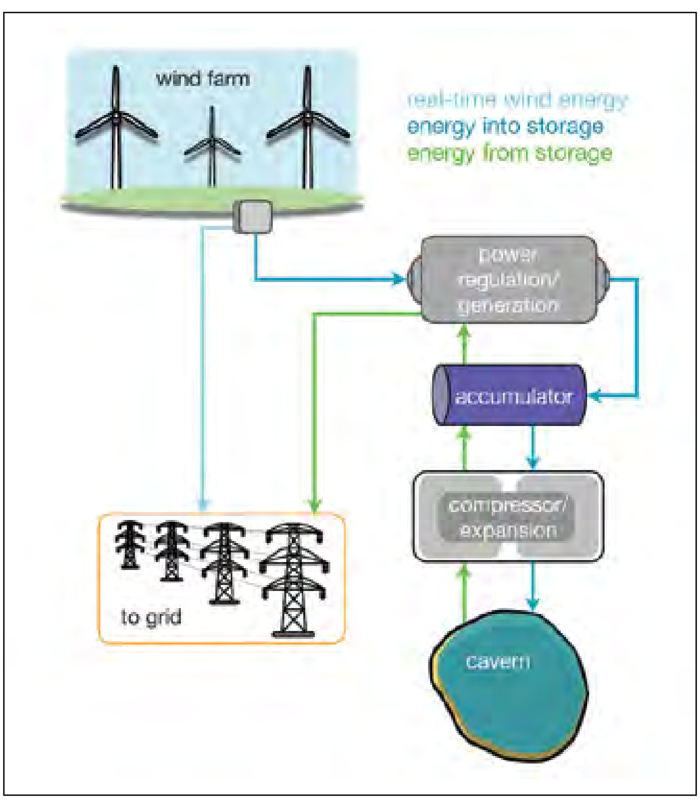


Image courtesy of General Compression

Dispatchable Wind Power Uses Air Compressor

General Compression is developing the Dispatchable Wind Power System (DWPS™) to transform wind into a reliable, renewable power source. Wind farms have received a lot of attention as an important renewable energy source in the future, but the question remains, how do they serve their customers when there is no wind? Justin Aborn, the Chief Scientist at General Compression, says, "We are the back-up plan. With our technology, the wind farm can continue to generate power during wind-stall periods."

Winds can be predicted quite accurately over thirty-day periods. It's the day-to-day wind that is erratic. "Today, wind farms are not reliable enough on a day-to-day basis to supply baseload or peak demand requirements," says Aborn. "Our systems will allow a wind farm to dispatch energy on-demand for these requirements."

The DWPS™ has three primary elements: Dispatchable Wind Turbines (wind turbines equipped with the Dragonfly™ air compressors, compressed air storage and expansion/generation equipment. The Dispatchable Wind Turbines house the air compressors, which use wind as the power source to compress air. Once the air is compressed to a compression range between 750 and 1,500 psi, the compressed air is stored in geologic features present at the site like underground salt domes. When the wind isn't blowing, custom control algorithms send the compressed air to generators which can dispatch energy on-demand using the compressed air as a power source.

"The challenge was to design an air compressor which could deliver high-pressure air with a varying power source — and make it reliable enough to be up in the nacelle of the turbine," said Mr. Aborn. "We could not find a commercially available design, so we set out to design our own." Mr. Aborn and his team worked with well-respected engineering firms like Ricardo and Belcan and came up with a positive displacement rotary screw air compressor that is a dry screw and takes the rotating shaft of the turbine rotor and feeds multiple stages of the air compressor. The design is currently patent pending. "We have the unit prototyped and have been testing the unit," says Mr. Aborn. "The target is to have the first power plant up and running in 2012."

For more information, visit www.generalcompression.com

DOE ITP's "Save Energy Now" Program Surpasses 2008 Assessment Goals

ITP conducted 691 Save Energy Now energy assessments in 2008 — exceeding the goal to complete 550 by years end. Save Energy Now assessments are performed at large U.S. manufacturing facilities by DOE Energy Experts and at small- and medium-sized plants through university-based Industrial Assessment Centers. Potential savings identified in 2008 include:

- Approximately $300 million in energy savings
- 18 trillion Btu — the amount of energy used to heat 360,000 single-family homes each year
- 1.2 million metric tons of carbon dioxide (CO_2) emissions — the equivalent of taking more than 200,000 cars off the road

A total of 1,900 assessments took place between 2006 and 2008, helping manufacturers save an average of 8% of their total energy costs. To date, Save Energy Now assessments have identified more than $1 billion in potential energy savings and saved industry $173 million.

For more information visit www.eere.gov/industry/

UTILITY-AIR NEWS

> "To date, DOE Save Energy Now assessments have identified more than $1 billion in potential energy savings and saved industry $173 million."

New 50kW Waste Heat Generators Use Rotary Screw Air Ends

ElectraTherm, Inc. (www.electratherm.com) today announced the successful completion of its 2008 Series A common share capital raise, totaling $2.6 million. The product of four years of successful research and development, the **ElectraTherm Green Machine** stands alone as the first commercially viable generator to make electricity from low-temperature, residual industrial heat that has, until now, gone to waste.

"ElectraTherm's disruptive technology is truly rewriting the book on clean energy production," said ElectraTherm investor Mike Acheson, Managing Director of Interlaken LLC. "Industrial waste heat is everywhere and the global market is poised to benefit from ElectraTherm's patented technology."

Key to its sales and manufacturing strategy, ElectraTherm recently entered an agreement with Taiwan-based Kaori Heat Treatment to manufacture and distribute 50kW Waste Heat Generators for the Taiwanese market. As the company accelerates domestic expansion, Eisenmann Corp. and Roughrider Power have joined Gulf Coast Green Energy as distributors of ElectraTherm products in the United States.

"The response from customers, investors, manufacturers and dealers has been very positive as news has spread about the ElectraTherm Green Machine," said Richard Langson, CEO of ElectraTherm. "The growing momentum is not surprising since our technology taps into the largest single source of immediately available renewable energy according to the **U.S. Department of Energy** — untapped geothermal and industrial waste heat."

Using **patented heat and pressure recovery technology,** ElectraTherm employs its proprietary twin-screw expander to generate fuel-free, emissions-free electricity at the lowest operating costs and fastest paybacks in the industry. Texas distributor Gulf Coast Green Energy installed the first commercial 50kW ElectraTherm Green Machine this summer at Southern Methodist University in Dallas. The machine has exceeded its 50kW output rating by 20%, garnering positive reviews from SMU's world renowned Geothermal Laboratory.

Potential customers may benefit immediately by contacting ElectraTherm distributors, including:

> **Eisenmann Corporation,** serving the United States and specializing in applications capturing heat or pressure from the emissions from thermal oxidizers and drying technologies in the ethanol and/or bio-renewable fuels industry.
>
> **Roughrider Power,** serving customers in Wyoming, Colorado, Montana and Idaho and specializing in oil and gas, coal, geothermal, stationary engines and turbines.
>
> **Gulf Coast Green Energy,** serving customers in Texas, Arkansas and Louisiana and specializing in oil and gas, coal, geothermal, stationary engines and turbines.

For more information on ElectraTherm and its clean-tech, green-power products, please visit www.electratherm.com.

DOE Awards Contracts and Reports 2008 Results

The U.S. Department of Energy (DOE) has announced that 16 new Energy Savings Performance Contracts (ESPCs) will be awarded that could result in $80 billion in energy efficiency, renewable energy and water conservation projects at federally-owned buildings and facilities. The new contracts will be available to all U.S. federal agencies for use in federal buildings located in the U.S. and overseas. Each contract allows for up to $5 billion in energy- and water-saving projects, without restriction on the technologies used to achieve savings.

ESPCs are contracts under which a contractor designs, constructs and obtains necessary financing for an energy-savings project, and guarantees the improvements will generate savings. The federal agency makes payments over time to the contractor from the savings in their utility bills. Once the contract ends, all continuing cost savings accrue to the federal agency.

The federal government is the largest single user of energy in the United States. As a result, DOE launched the Transformational Action Energy Management (TEAM) Initiative in 2007 — a partnership between the Federal Energy Management Program and other federal programs, including ITP, to help all federal facilities meet the energy-saving goals outlined in Executive Order 13423. These goals include a 30% reduction in energy use (from 2003 levels) and a 16% reduction in water use (from 2007 levels) by 2015.

Compressed Air Audit of the Month

Boiler Soot Blowing in Power Plants

By Hank Van Ormer, Air Power USA

February Audit of the Month

Where:	Midwest, United States
Industry:	Coal-Fired Power Plant
Issues:	Older Compressor Technology
Audit Type:	Supply and Demand Side

System Before Audit

Operating Hours:	8,760 hours
Power Cost (kWh):	$0.06
Low-Pressure Air (100 psig):	
Ash Air:	1,469 scfm
Control Air:	1,212 scfm
Station Air:	2,334 scfm
Subtotal:	5,020 scfm
High-Pressure Air (300 psig):	7,480 scfm
Total Air Flow:	12,500 scfm
Total Energy Cost:	$2,449,876

Audit Actions:

1. Boiler soot blowing best practices
2. Install new 1,500 horsepower, centrifugal air compressor with more effective turndown for 300 psig air

Audit Results:

Low-Pressure Air (100 psig):	4,020 scfm
High-Pressure Air (300 psig):	6,730 scfm
Total Air Flow:	10,750 scfm
Air Flow Reduction:	1,750 scfm
Total Energy Cost:	$1,062,238
Total Energy Savings:	$1,387,638
Energy Savings %:	43%
Project Cost:	$1,462,700
Simple Payback:	12.6 months

Best Practice Guidelines for Boiler Soot Blowing

Utilities have been cleaning their boilers for many years using either steam or high-pressure air. In the past, when air was used, due to the size of the boilers and the reasonable quality of fuel used, a relatively small amount of cleaning was required.

In the past decades, larger power-generating stations were built and the quality of fuel deteriorated requiring a greater amount of cleaning with shorter cleaning cycles.

With these changes, larger compressors became a necessity when air cleaning. Reciprocating compressors were unable to compete on an economic basis in the larger capacities due to their relatively small capacities, initial cost, high installation costs and space requirements for multiple compressor installations. Centrifugal compressors have been used in utility soot blowing in a limited amount since the early 1950s, but the reliability and efficiency of early high-pressure designs left a great deal to be desired.

From the late 1960s through the early 1980s, compressor manufacturers made great strides in the development of the high-pressure, multi-stage, centrifugal air compressors, utilizing the advances in centrifugal technology and manufacturing capabilities. They extended these advances in efficiency, reliability and compactness to the high-pressure units (300 to 500 psig). This makes them the most viable option for economic, large-volume, high-pressure compressed air, such as required in a soot blowing system.

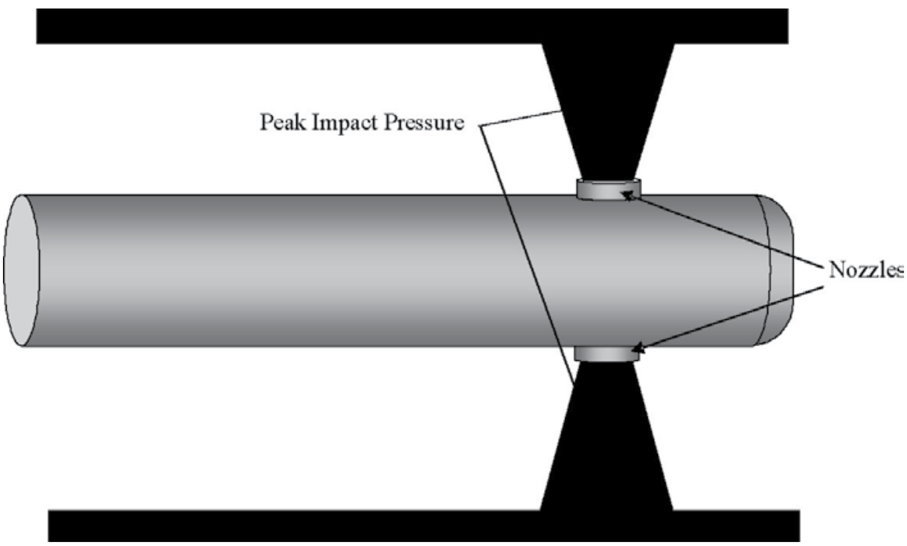
Air vs. Steam for Soot Blowing in Boilers

Generally speaking, soot blower manufacturer's lances, with some modifications, will handle either cleaning media steam or compressed air.

Cleaning energy is usually defined as:

$$\text{Fluid horsepower} = \frac{WV\ (P\times 144)}{33{,}000}$$

Where: W is flow in lbs/min
V is specific volume in ft^3/lb
P is psig at the nozzle



This fluid horsepower relates equated kinetic energy at the point of impact to the surface soot removal. This relationship is called "Peak Impact Pressure."

A nozzle designed properly for air or another designed for steam will clean an area equally effectively. Other more important criteria that are used to determine the boiler cleaning media are listed below:

Geographic Location — An area that has quality water available may be more prone to use steam.

Quality of Water — Chemically hard water would be a detriment with a steam cleaning system due to the high cost of chemically treating the water.

Capacity of Steam or Air — An excess of steam or air due to operational changes may influence the decision including operator familiarity and comfort with either media.

COMPRESSED AIR AUDIT OF THE MONTH

Boiler Soot Blowing in Power Plants

Looking at air vs. steam on an economic basis:

STEAM VS. AIR ECONOMICS	AIR	STEAM
Operating Cost	Approximately equal but depends on quality of steam used and quality of H_2O make-up.	
Initial Cost	Purchase of a compressor is a large negative.	Steam capacity can be built in at a moderate cost or may be already available.
Piping Cost	Air piping is generally less expensive than steam.	Steam system is very expensive with piping insulation, steam traps, drip legs, etc.
Reliability	Obtaining adequate reliability for constant sustained use requires a redundant compressor.	Steam available as long as boiler is in operation.
Maintenance of Piping and System	Air piping is usually low maintenance.	Steam piping system requires higher maintenance.
Equipment Maintenance	New compressors add to the maintenance-required effort.	The boiler is already being maintained.
Off-Load Capability When Not Needed	Larger horsepower centrifugal compressors do not readily shut down for short duration and often must stay on running inefficiently.	Steam can easily be turned off and on.

Deploy a Dedicated Low-Pressure Air Compressor

Often because the large horsepower, high-pressure compressors cannot easily be shut off and also have to run the low-pressure (100 psig) plant, service and instrument air is taken from the high-pressure receiver that is regulated down to the low pressure. **This is very inefficient compared to running a dedicated, low-pressure compressor.**

On a recent compressed air audit at a Midwestern power plant, we developed the following data profile. All costs are based on the power plants selling price of electricity, $0.06/kWh at 8760 hours per year. The progressive thinking here is, “If you don’t use the energy to produce electric power — you can sell it.”

All the compressed air, high pressure and low pressure, was supplied by the High-Pressure, “Soot-Blowing Compressors,” 12,500 scfm at an annual electrical energy cost of $195.99 scfm per year or $2,449,876 per year.

The low-pressure system has been supplied since the mid 1990s by the high-pressure centrifugals and regulated down to the 100 psig class level. Initially, the low-pressure air demand was relatively small, and it made more sense to use regulated low pressure rather than start up another low-pressure compressor and still not being able to shut off any of the three, 2000 hp, high-pressure centrifugals. In effect, the low-pressure air compressor would be on and the large horsepower centrifugal would go into "blow off" with no net input energy savings and probably a net increase into the compressed air supply. During the last decade, the demand for low pressure increased, and the utility called for us to evaluate the total system. Measurement and observation gave us the following demand profiles:

Estimated demand for low pressure:

Ash air:	1,469 scfm
Control air:	1,212 scfm
Station air:	2,334 scfm
Total:	5,020 scfm

Estimated demand for high pressure:	7,480 scfm
Total Air Flow:	12,500 scfm

At the end of the audit and implementation, air conservation programs reduced this to:

Low-Pressure Air:	4,020 scfm
High-Pressure Air:	6,730 scfm

COMPRESSED AIR AUDIT OF THE MONTH

Boiler Soot Blowing in Power Plants

This demand for low pressure was satisfied with a 6,000 scfm base load compressor and 1,400 scfm of VSD driven trim unit. The remaining 6,730 scfm of high-pressure air (300 psig) demand was satisfied by running one of the 2,000 hp original units and a new, additional 1,500 hp smaller centrifugal with 25% turndown. The newer unit is then 20% more power efficient then the original with almost 15% more effective turndown.

- The new 1,500 hp compressor was more power efficient than the older 1995 units due to better manufacturing and advanced design
- The smaller centrifugal with more effective turndown was applied to the demand at 75% flow, 80% power and generally "not running in blow off." Previously, the three older units were all running normally with two in "blow off." This improved the overall high pressure efficiency about 20%
- The low pressure was obviously producing at a much better, specific power. An improvement of 48% compared to the previous high-pressure air regulated down
- The total savings reduced the annual electrical energy cost by 43% or $1,387,638 per year. The total project cost was $1,462,700, a simple payback of a little over one year (12.6 to 12.2 months)

Other Soot-Blowing Operational Considerations:

Tube Erosion

When steam is used as a cleaning medium and a soot blower starts it's blowing cycle, there normally is a temperature differential between the soot blower and the steam. When this happens, steam condenses and slugs of water are ejected from the soot blower nozzle. After repeated cycles, the slugs may erode the tubes in the boilers requiring plugging of the tubes and eventually replacement. Tube erosion can often be a more significant problem in a steam system than in a compressed air system.

Soot-Blowing Cycles and Considerations

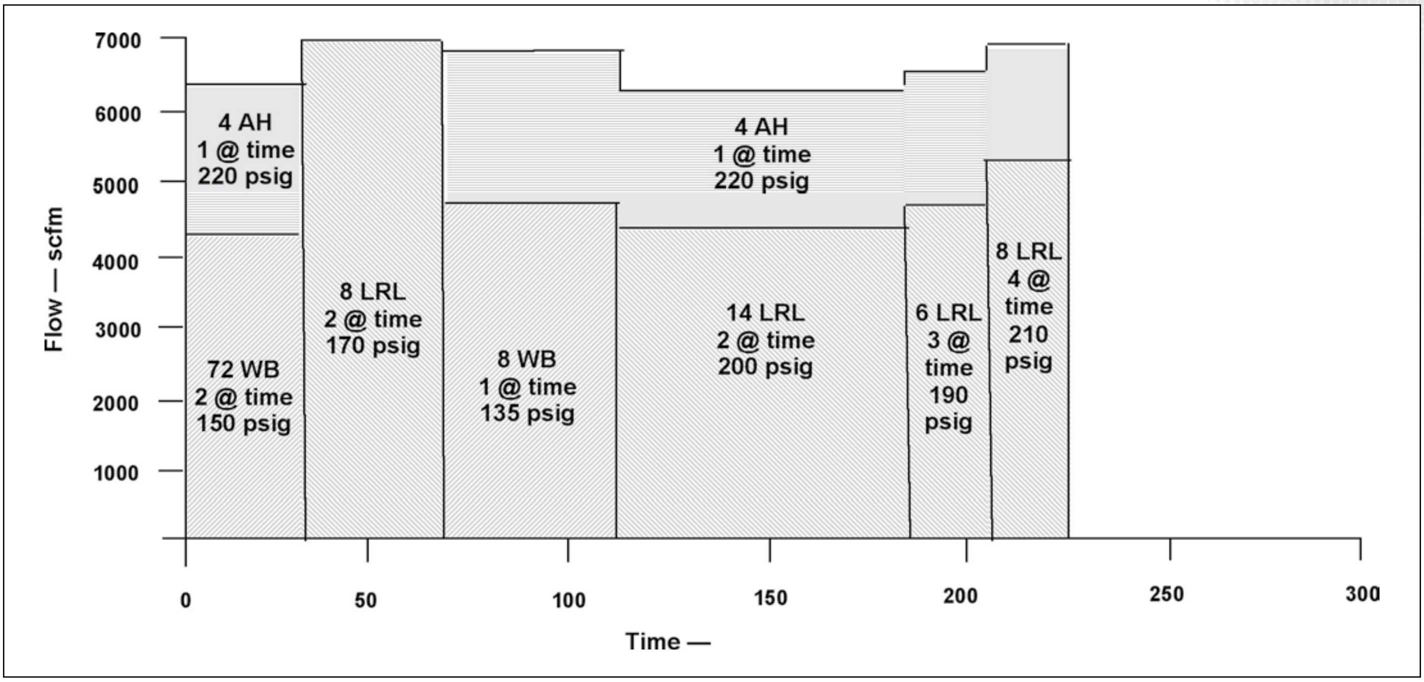
A cleaning cycle is a period of time in which required blowers are cycled in a pre-arranged sequence to clean given areas of a boiler over a period of time. Many variables are intermeshed in determining a cycle, some of which are:

- Size of boiler
- Time period for cleaning
- Type and quality of fuel used
- Type of blowing (stacked or single)
- Highest soot blower capacity requirement
- Personnel preference for a given time period

Most of these items are variable and should be considered in detail before the system specifications are written. Some ways a blower cycle can be reduced or expanded after installation are to:

- Increase or decrease linear travel rate of long retractable lances (soot blowers)
- Increase or decrease number of revolutions of the wall blowers
- Increase or decrease pressure at the nozzles/change or modify nozzles
- Operate parallel blowing systems when possible
- Speed up the control sequence where one blower starts extending out into the boiler before the prior one is fully retracted
- Modifications to the IR rods to allow use at lower pressure during refraction limit just enough for cooling
- Changes to control valves/regulators with less pressure loss

Typical Bar Chart — Typical Compressed Air Soot-Blowing System with Stacking:



"Stacking Considerations" — Operating Parallel Blowers When Possible

It is poor practice to blow in the pendant reheat surface at the same time the wall blowers are in use. The control system can be arranged so this will never occur. Blowing an air heater at any time usually has no disturbing effect on the boiler, nor does blowing any horizontal boiler surfaces, which usually includes primary reheater, superheater and economizer surface.

The concept of "stacking," which helps to level load the compressed air system, may create some problems for the boiler, with significant temperature excursions. Larger boilers would experience much lower magnitude of upsets. Pressure requirements vary greatly from lance to lance. Normal ranges are from 135 to 260 psig at the nozzle of the blower. Pressure is related to the cleaning energy (PIP) required for a given area and cooling requirements.

Cooling long, retractable lances in higher temperature areas of the boiler uses a substantially greater quantity of air for cooling than for cleaning and at a higher pressure. A high pressure for the long retractable lances is often required to accommodate the pressure drop associated with the high flow rates and long lengths of the blowers. Typical cooling requirements for long retractable lances are:

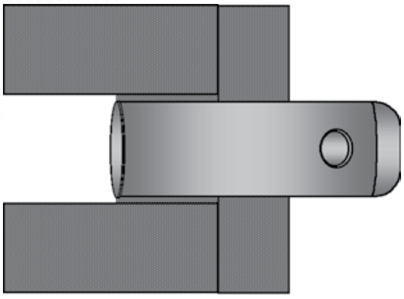
Lance Length	Approximate Cooling Requirements
40 ft.	6,000 scfm or more
50 ft.	9,000 scfm or more

COMPRESSED AIR AUDIT OF THE MONTH

Boiler Soot Blowing in Power Plants

Required compressor pressures are normally conservatively picked to account for large pressure drops through the piping system and control valves of the soot blowers. The overall pressure drop may be as high as 100 psig from the compressor discharge to the soot blower nozzle. Approximately 50 psig maybe lost in the control valve at the entrance to the lance. This is often recoverable.

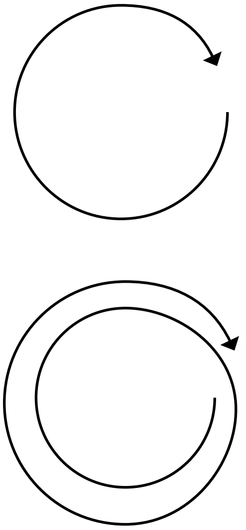
Wall Blowers or IR Blowers



Wall blowers are used to clean the furnace walls and will probably use approximately 2,200 to 2,300 scfm. Wall blowers normally operate in one or more pairs depending on the overall cycle. Their basic job is to reduce slag that has accumulated on the pipes in the upper levels of the boiler and superheated region. When the slag builds up on the pipes, the rate of heat transfer decreases. This will lower the temperature of the steam going to the superheated portion of the system therefore decreasing overall efficiency of the system.

A normal cycle for a wall blower starts when it energizes and moves out into the furnace to its outermost position where the control valve opens and air starts flowing. It takes three seconds to go from zero to full flow. The wall blower rotates one or more times depending on the amount of cleaning required and then the control valve closes in three seconds and the blower retracts into the wall.

The time for a wall blower cycle is approximately three to six minutes and the period of zero flow between wall blower flow to no-flow to flow can be as high as 1.5 minutes in a normal sequence. This may be reduced if cycle time needs to be reduced by overlapping.



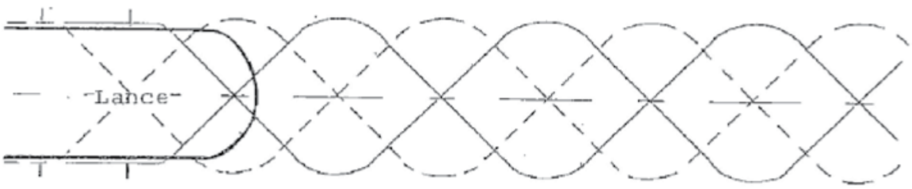
One or more revolutions for cleaning

Long Retractable Lances or IR Blowers

Long retractable blowers are used to clean pendant-type radiant surfaces and convection surfaces in high-temperature zones as well as convection passes to reduce slag buildup on the walls of the boiler and for temperature control. These areas are normally in the superheater, reheater and the economizer section.

The long retractable lance cycle starts when the lance energizes and extends into the boiler and air starts flowing with the three-second delay from the control valve. The lance travels outward and rotates at the same time. The linear speed varies from 65 to 150 inches per minute depending on the cleaning and temperature zone requirements.

Long Retractable Lance Cleaning Pattern



– – – – – – Retracting

———— Extending

Long retractable lances vary in length with the boiler size and are one-half the width of the boiler. Cooling is very critical with these lances since they may operate in temperature zones up to 2,000 °F and are cantilevered out from the side of the boiler walls.

Air Heaters

The long retractable blowers are often also used in the air heater section. Sometimes a "swing arm" type blower may be used in the air heater section. This will use a lower magnitude of compressed air but will generally require a longer cycle.

System Interlocks

Several safety interlocks can be provided on soot blowing systems. One or more of the interlocks listed below may be used:

- Main manifold system air pressure
- Air pressure interlock at individual lances
- Air flow to lances

These safety interlocks are used to prevent damage due to low air pressure or flow to the lances, especially the long retractable lances while they are operating in the boiler.

The loss of a lance will reduce boiler efficiency and eventually will lead to a plant shutdown. BP

For more information, please contact Hank Van Ormer: tel: 740-862-4112, email: hankvanormer@aol.com, www.airpowerusainc.com

"The loss of a lance will reduce boiler efficiency and eventually will lead to a plant shutdown."

AIR STANDARDS

ISO8573 Part 1 — Contaminants and Purity Classes

BY DAN RYAN, ENGINEERING MANAGER-FILTRATION, PARKER HANNIFIN

Industry standards serve a very important purpose for the end users of compressed air equipment. If the standards are well written, they can help to promote the equipment that they govern as long as the equipment manufacturers properly apply and promote the standards. One of the most widely used standards in use today in the compressed air industry is ISO8573. It is a multipart standard that seeks to establish a method of classifying the purity of compressed air in Part 1 then gives us the tools for measuring and quantifying that purity in Parts 2 through 9.

ISO8573 is arranged as follows:

- Part 1: Contaminants and Purity Classes
- Part 2: Test methods for oil aerosol content
- Part 3: Test methods for measurement of humidity
- Part 4: Test methods for solid particle content
- Part 5: Determination of oil vapor and organic solvents content
- Part 6: Determination of content of gaseous contaminants
- Part 7: Test methods for viable microbiological contaminant content
- Part 8: Test methods for solid particle content by mass concentration
- Part 9: Test methods for determining liquid water content

In this article I will focus on Part 1 of ISO 8573 and describe why the standard was developed, how it should be used and what the future holds for this standard in the compressed air industry. But before we look at Part 1 of ISO8573, we need to take a look at what causes compressed air to be "impure."

How successfully compressed air stream cleanliness requirements are met can have a dramatic impact on overall plant operating costs. Excessive contamination shortens the life of components and systems, adversely affects product quality, can result in excessive maintenance costs and can even create health and safety problems.

Contaminants in the form of solid particulates, oil aerosols and vapor, water aerosols and vapor and even unwanted gaseous vapors can be introduced from the plant environment, ingested by the compressors or created by the air compressor and distribution system.

While many compressed air applications require a high degree of purity, all compressed air applications work better if the air is clean and dry. However, when the air leaves a compressor, it is anything but clean and dry.

Sources of Contamination

Contaminants in compressed air systems have three possible points of origin. They can come from the air drawn into the compressor, from internal compressor mechanisms and from the compressed air distribution system. Compressors draw in virtually all particles, vapors and gases in the air within a six-foot radius of the inlet. Smaller particles, less than 10 microns in size, can be drawn in from a larger radius. The compressor inlet filter is designed to stop larger particles that could cause rapid wear of compressor parts. This design prevents excessively frequent replacements of the air intake filter element, but it does little to protect sensitive applications downstream of the compressor. Most of the airborne particles smaller than 10 microns can enter the compressor. Also, any gases and vapors around the intake will enter the compressor and become part of the compressed air supply. These include combustion by-products such as carbon dioxide, carbon monoxide, nitrous oxides or sulfur dioxides.

Another factor affecting air contamination is that during compression to 100 psi, the air volume is reduced by a factor of seven, meaning seven cubic-feet of ambient air becomes one cubic-foot of compressed air. The result is an increase in the concentration of airborne particles in the compressed air stream. After compression, some of the most common airborne contaminants include dirt and pollen particles, iron oxide (rust) particles, microorganisms, unburned hydrocarbons, liquid water, water aerosols and water vapor and oil aerosols and vapor.

Now that we know what the contaminants are made up of, we can take a look at how the ISO standard is used to classify the type and amount of contamination in compressed air.

AIR STANDARDS

	Solid Particulate					Water		Oil
	Maximum Number of Particles per m^3			Particle Size	Concentration	Vapor	Liquid	Total Oil (Aerosol, Liquid and Vapor)
Purity Class	0.1–0.5 microns	0.5–1 micron	1–5 microns	micron	mg/m^3	Pressure Dew Point	g/m^3	mg/m^3
0	As specified by the equipment user or supplier					As specified by the equipment user or supplier		As specified by the equipment user or supplier
1	100	1	0	—	—	-70 °C/-94 °F		≤ 0.01
2	100,000	1,000	10	—	—	-40 °C/-40 °F		≤ 0.1
3	—	10,000	500	—	—	-20 °C/-4 °F		≤ 1
4	—	—	1,000	—	—	+3 °C/37 °F		≤ 5
5	—	—	20,000	—	—	+7 °C/45 °F		—
6	—	—	—	≤ 5	≤ 5	+10 °C/50 °C		—
7	—	—	—	≤ 40	≤ 10	—	≤ 0.5	—
8	—	—	—	—	—	—	≤ 5	—
9	—	—	—	—	—	—	≤ 10	—

Chart taken from ISO8573.1 : 2001

The Purity Classes

The current version of ISO8573 Part 1 was published in 2001 and is currently in the process of being revised. Every five years, ISO standards are reviewed to determine whether they are still timely, accurate and useful to the industries that they serve. If the Working Group, which is made up of volunteer industry experts, decides that the standard requires no revision, then nothing is done to change the standard, and it retains its current publication date. If the standard is revised, then a new publication date is assigned to it once the revision has completed the required balloting procedure. When referring to an ISO standard, it is common practice to include the publication date, so you may see Part 1 of this standard referred to as ISO8573.1 : 2001.

There are three categories of contaminants that have been assigned classes in ISO8573.1 : 2001. The first category is solid particulates. The second category is made up of a combination of liquid water and water vapor. The third category is called oil, and it consists of the sum of the liquid oil (in aerosol or liquid droplet form) and oil vapor. The chart above summarizes the three categories of contaminants and shows the limits of contamination that are required to differentiate one purity class from another.

The purity classes range from the cleanest, Class 0, to the most impure, Class 9. Note that not all of the categories have the full range of classes, only the water category does. Also, notice that Class 0 does not have any numbers associated with it in any of the categories. In the text of ISO8573.1 : 2001, Class 0 is defined by stating, "As specified by the equipment user or supplier and more stringent than Class 1." It is very important to understand that Class 0 does not imply that there are no contaminants present; it simply means that there are fewer contaminants than in Class one.

Solid Particulates

There are eight possible classes for solid particulates, from Class 0 to Class 7. Class 0 is the most pure, but it is numerically undefined other than to say that it must be more pure (fewer particles in each size range) than Class 1. Classes 0 through 5 are defined by the number of particles in a particular size range, in one cubic-meter of compressed air. Measurement methods are described in Part 4 of ISO8573 for Classes 0 through 5.

Classes 6 and 7 are used to describe compressed air that is typically too "dirty" to be measured with a particle counter. Instead, mass measurements are used to determine the amount of particulate contamination in the compressed air, according to Part 8 of ISO8573.

Water

There are 10 possible classes for water contamination, from Class 0 to Class 9. Class 0 is the driest, but it is numerically undefined, other than to say that it must be drier (a lower pressure dew point) than Class 1. Classes 0 through 6 are defined by the pressure dew point of the compressed air. Pressure dew point is defined as the temperature at which moisture begins to condense in the pipes and storage tanks of a compressed air system while it is operating, and hence, under pressure. Pressure dew point is a useful method of describing the humidity in compressed air because it tells us that we must keep the ambient temperature that surrounds the compressed air distribution system above the pressure dew point in order to prevent liquid water from condensing inside the piping. Pressure dew point measurements are described in Part 3 of ISO8573.

Classes 7 through 9 are used to describe compressed air that contains liquid water. As mentioned, liquid water appears in the distribution piping and storage when the pressure dew point of the compressed air is higher than the temperature of the ambient air, and it means that the compressed air contains as much water vapor as is possible for it to contain. This condition is usually called "saturated" air. When liquid water is present in the compressed air line, we use the methods described in ISO8573, Part 9 to measure the amount.

> "How successfully compressed air stream cleanliness requirements are met can have a dramatic impact on overall plant operating costs."

Oil

There are only five classes for oil in the standard, but they describe a wide range of concentrations. Again, Class 0 is the most pure, and according to the standard, it describes compressed air that must be more pure than Class 1. Classes 1 through 4 cover the range from less than 0.01 mg of oil content per cubic meter of compressed air to less than 5 mg per cubic meter.

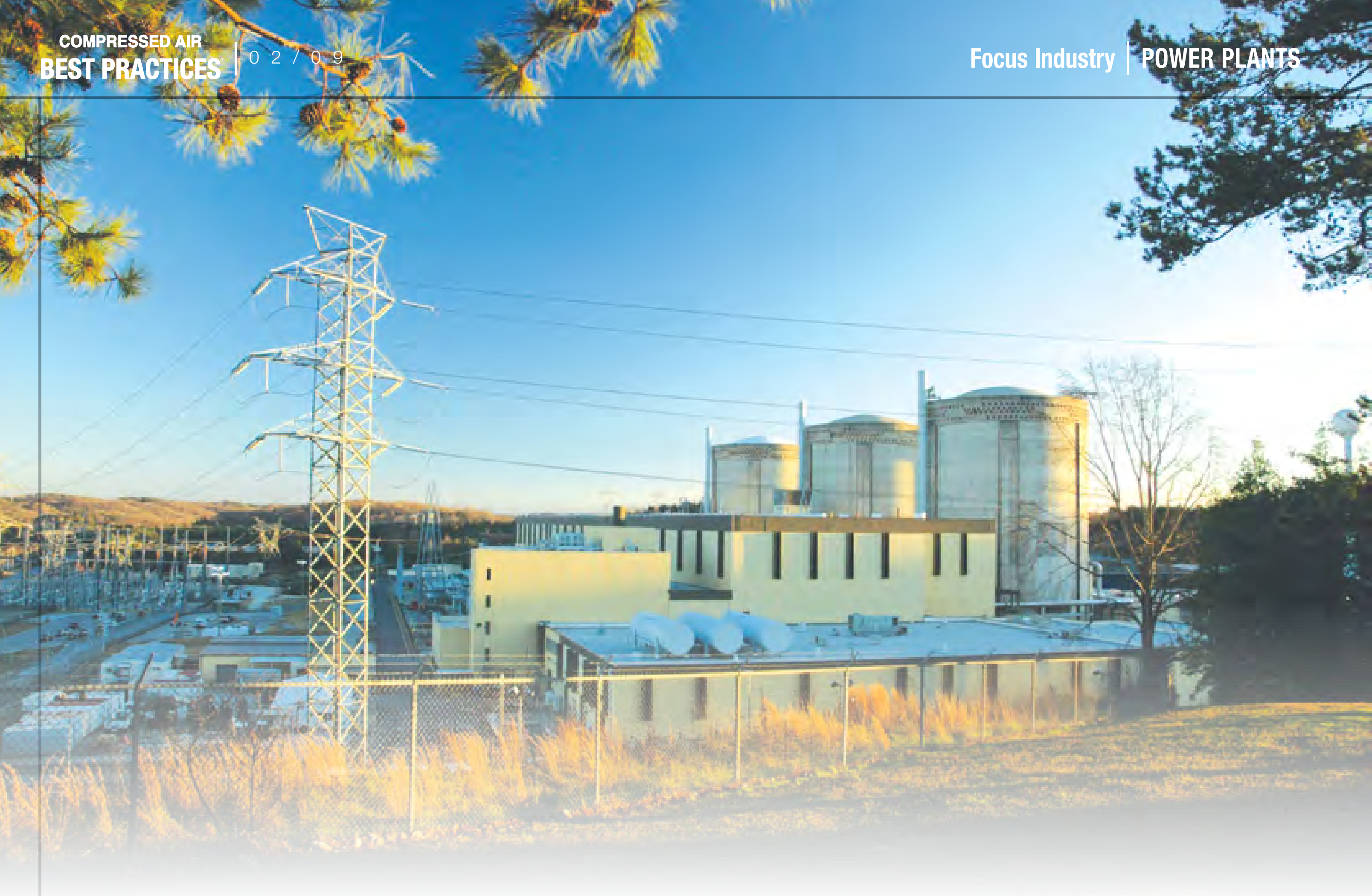
It is very important to understand that the oil classes can only be determined by adding the contribution from a.) any liquid oil in the compressed air, b.) the oil aerosols in the compressed air (typically generated by the reciprocal or rotary motion in lubricated compressors) and c.) oil vapors that can come from the oil in the compressor crankcase or sump or from ingestion at the inlet of the compressor. Liquid oil and oil aerosols are measured using the techniques in ISO8573, Part 2, and the oil vapors are measured using the methods in Part 5.

Reporting the Purity Classes

According to the standard, the purity classes of compressed air shall be expressed by stating the standard reference number and part, the date of issue and the three class designations in a specific order: Particulate Water Oil. For example, if the compressed air purity of an audited air system was expressed as ISO8573.1 : 2001 1 2 1, the Particulate Class would be 1, the Water Class would be 2 and the Oil Class would be 1. If the class for a particular category is omitted, then a hyphen is used in its place.

Many manufacturers of equipment powered by compressed air are now using this standard to express the purity level of the compressed air supply required in order to keep their tool or process running smoothly and in control. Air tool manufacturers and paint and powder coating suppliers are just two examples of entities that are using ISO8573 to improve their customer's satisfaction with their products. BP

For more information, please contact Dan Ryan, Engineering Manager — Filtration, Parker Hannifin Corporation, Filtration & Separation Division: tel: 248-236-8234, email: DRyan@Parker.com, www.Parker.com



Instrument Air in Nuclear Power Plants

BY BILL EISTER, OCONEE NUCLEAR STATION, DUKE ENERGY

Introduction

Nuclear power plants produce electricity for people, business and industry. Electricity is produced in a similar fashion as in fossil fuel (i.e., coal, oil, etc.) power plants, using steam to drive turbines, which spin an electrical generator producing the electricity. Energy, in the form of heat, to produce steam comes from the fission of Uranium235 atoms rather than the burning of fossil fuels. Once energy has been removed from the steam, the remaining energy is either used in preheating condensate (liquid water) that will be used to make more steam or it is removed in a condenser heat exchanger. In the condenser, the steam condenses to liquid as energy is removed by cooling water from a lake, ocean, river or to the atmosphere via cooling towers. Once the remaining energy is removed and the steam becomes liquid condensate, the liquid condensate is reheated in the steam generator, producing high-energy steam for use in the turbine (1)(2).

Instrument Air for Measurement and Safety

To produce electricity in the most efficient manner, the flow of steam and condensate, as well as levels in the heat exchangers must be monitored and controlled. Many of the instruments that monitor flow, level, pressures and temperatures incorporate instrument air quality compressed air (instrument air) to transfer information. Flow and level control is accomplished by the throttling operation of air-operated valves (AOVs). The AOVs require instrument air (clean, dry compressed air). Normally, the resulting load on the Instrument Air System is relatively constant. The high-quality air prevents the small ports on instruments, controls and AOVs from becoming clogged with debris, moisture or oil, which could prevent the proper operation of the equipment supporting the efficient production of electricity.

As noted, nuclear energy is produced by the fission of Uranium235. The fission process, as well as fission products resulting from the fission, produces radiation. The safe and proper operation of a Nuclear Power Plant ensures the nuclear fuel and fission products will be contained in an acceptable configuration so as to not cause harm to plant operators or the general public. At some nuclear power plants, instrument air is required to assist in safely shutting down a nuclear power plant in the event of an emergency ensuring that the barriers to the release of radioactive contamination will be maintained. Yet, in most nuclear power plants, instrument air is not required to perform these functions as all the components required to perform these functions either do not use compressed air or the air controlled components fail in the position required to prevent release of radioactive contaminants (3).

As at all industrial facilities, compressed air is also used for supplement uses such as operating air driven tools and pumps. This is commonly designated as service air and is separate from the Instrument Air System. The Service Air System may be used as backup for instrument air.

Instrument Air at the Oconee Nuclear Station

Oconee Nuclear Station's (ONS, three unit station) original Instrument Air System configuration incorporated three Worthington Reciprocating Compressors (HBB 14x13, 489 cfm each) supported by refrigerant dryers. During initial startup and operation, Oconee's Instrument Air system normally operated with two compressors in run, one in standby, supporting the operation of the air-operated valves and instruments of Units 1 and 2 as well as tooling and sewage ejectors. ONS realized more compressed air capacity was required. In the mid 1970s, a separate Service Air System was installed, using two oil-flooded Sullair Rotary Screw compressors (150 Series), to support tooling and sewage ejectors.

CANUG

The Compressed Air Nuclear Users Group (CANUG) was formed in 1988 with the objective being to exchange information between Compressed Air Systems Engineers serving nuclear power plants. Eighty members share the need to improve the reliability, availability and reduction in cost of the compressed air systems that serve the valves, instruments and other components utilizing compressed air in controlling the conversion of nuclear energy to electricity.

www.aovusersgroup.com/canug.html

INSTRUMENT AIR IN NUCLEAR POWER PLANTS

"In order to use nuclear energy safely, the nuclear industry needs to work together."

The Service Air System was tied in to the Instrument Air System as a backup. This proved advantageous as well as problematic. The Worthington's were high maintenance and Service Air was often used to supplement Instrument Air. Since the Service Air system was supported by oil-flooded compressors, the Instrument Air System was frequently contaminated by oil causing operational problems. The oil problem was eliminated with the installation of Deltech Color Change filters at the Service Air to Instrument Air crossover.

By the mid 1980s, the Nuclear Regulatory Commission (NRC) had gathered quite a bit of data concerning problems experienced at nuclear power plants that resulted from poor instrument air quality and reliability. The NRC issued Generic Letter 88-14 (INSTRUMENT AIR SUPPLY SYSTEM PROBLEMS AFFECTING SAFETY-RELATED EQUIPMENT). This report referenced NUREG-1275, Volume 2, "Operating experience Feedback Report — Air Systems Problems," which indicated "that the performance of the air-operated, safety-related components may not be in accordance with their intended safety function because of inadequacies in the design, installation and maintenance of the instrument air system."

In addition to Generic Letter 88-14 (4), the Institute of Nuclear Power Operations (INPO) issued Supplemental Operating Experience Report (SOER) 88-1 (Instrument Air System Failures), written to address system failures that had been initiated by poor quality instrument air (IA). It noted at that time, "system failures, caused by instrument air failures, are occurring at a rate that indicates greater attention to instrument air systems is warranted." (5)

Addressing Issues with Instrument Air

ONS, as well as the rest of the Nuclear Industry, addressed these issues. At ONS, an additional air compressor was installed; Sullair 32/25 400, a 2,200 cfm, oil-flooded tandem rotary screw compressor. Dual two-stage pre-filters and two SAHARA heatless desiccant dryers (each rated at 1,400 scfm) were installed in parallel downstream of the new compressor. This configuration, now the primary source of instrument air, operates approximately 340 days per year and is taken out of service each quarter for preventive maintenance. The Worthington compressors have become the backup source of air and the supporting refrigerant dryers were replaced with two 750 scfm heatless SAHARA desiccant dryers installed in parallel. This arrangement has worked well, providing a much more reliable source of dry, clean compressed air (6).

Oconee Nuclear Station is unique with its Instrument Air System configuration, using an oil-flooded compressor as well as having one central source supply for all three nuclear units. A majority of the nuclear industry use oil-free compressors, rotary screw or centrifugals. Most of their systems are configured such that each nuclear unit has its own air source. Though each unit has its own source, most sites have cross connects between the units instrument air supplies. The cross-connects are kept isolated except during emergencies, ensuring that a problem on one air system does not affect the operation of multiple units.

INSTRUMENT AIR IN NUCLEAR POWER PLANTS

The CANUG 2009 Conference was held at Disney's Contemporary Resort and featured Compressed Air Challenge® training. The trainers were Bill Scales and Tom Taranto.

Instrument Air Specifications for New Nuclear Power Plants

There are new nuclear power plants on the horizon. These will be built or supplied as modular units. There will only be a few designs to choose from and therefore, the plants will be identical. By designing and building them this way, it will be much more cost effective and easier to have them licensed for power operation. When the concept of similar power plants was first presented, CANUG took it on as a challenge. The challenge was to provide to the power plant designers with an ideal instrument air system configuration, one that was not only reliable but also cost effective and flexible. Each of the present CANUG members has an Instrument Air System which has some shortcomings and this was an opportunity to provide input to the future plant designers, eliminating those shortcomings.

Defense-in-Depth of Three

With respect to the Ideal Instrument Air System, the CANUG requests a defense-in-depth of three. This will allow for one instrument air train to be in "maintenance" while the other two are configured in "run" and "standby." Each of the three trains should consist of a compressor and associated inter-/after-cooler(s), wet receiver, pre-filter/mist eliminator, desiccant dryer and after filter. To enhance the flexibility, the component trains ought to have the ability to be cross-connected as well as have connections to the systems which would allow an outside source of air. Dry receivers should be used at the outlet of the after filters and as needed at the far reaches of the Instrument Air System.

The compressors should be sized to carry approximately 75% load to allow for growth or changes in system dynamics. Their suction sources should be in areas not subject to high temperatures, sources of contaminants or highly moisturized air. The compressor controls should be such that a failure on one controller will not affect the capabilities of the other two compressors.

The piping between the compressor and the dryer should be stainless steel so as to minimize the corrosive effects of highly moisturized air. This will also minimize the corrosion brought on by other atmospheric contaminants that could be initiated by the discharge from other industries in the area. Likewise, the wet receiver should be either stainless steel or coated such as to prevent corrosion.

The pre-filter should be a high-quality, coalescing filter supported by automatic drain traps. A "mist eliminator" should also be used depending upon the type of compressor used and the expected contaminants in the area of the suction of the compressor.

Drain traps (supporting the after-cooler/inter-cooler moisture separators, the wet receiver and the pre-filters) should be "Zero-Loss" drain traps with at least 3/8" ports to prevent blockage. Each of the drain traps should have their own individualized drain discharging to a sump. They should also be supported by a bypass line and valve that allows the drain trap to be removed from service for maintenance and yet allow the supported component to remain in service.

The CANUG discussed the type of desiccant air dryer to be used in this system and decided upon a heatless desiccant dryer. The reason was a simpler design and operation than the internally heated or blower purge dryers. We understand that in the long run this is more costly, but reliability was considered over cost. This may still be up for discussion.

Both wet and dry receivers should be installed. The wet receivers provide a surge volume for dryer purges as well as another opportunity to collect and condense moisture in the compressed air. The dry receivers prevent over rating the dryers on sudden surges in the instrument air header as well as an accumulator volume to support operation of downstream components.

The CANUG also considered installing dual-parallel pre-filters and after-filters to increase the margin of reliability. This allows the removal of a filter from service without taking the whole train out of service.

In addition to the monitors provided with the equipment installed, there needs to be additional monitoring capabilities in order to observe the health of the instrument air system. Dew point monitors should be installed at the outlets of each air dryer if they do not come as part of the air dryer package. There should also be sample taps throughout the system to allow periodic monitoring of air quality, downstream of each of the pre-filter/mist eliminators (oil and hydrocarbons) and the dryer after-filters (particulate and moisture) as well as strategic locations throughout the system. Moisture can enter the Instrument Air System through leaks and thus periodic moisture monitoring at locations downstream of the after-filters might prove advantageous (Fick's law). Flow and pressure indications should be available at strategic locations to provide an indication of use (trending) as well as assist in diagnosing problems.

"The Institute of Nuclear Power Operations provides an operating experience database of problems experienced throughout the nuclear industry that is regularly reviewed for applicability."

INSTRUMENT AIR IN NUCLEAR POWER PLANTS

Flow indication upstream of the dryers would provide input as to the purge being used by the dryers. It would be good to add the ability to measure the amount of electricity (kW, amps) being drawn by the compressors. This could provide valuable insight concerning the efficiency of the compressors as well as a second check of flow indications.

System Improvements

Since the issuance and response to NRC's Generic Letter 88-14 and INPO's SOER 88-1, air quality has not been a great issue other than ensuring we are continuing to meet the commitments we made in the past. However, reliability of the Instrument Air Systems continues to be a challenge. The Institute of Nuclear Power Operations provides an operating experience database of problems experienced throughout the nuclear industry that is regularly reviewed for applicability. Nuclear Power Plant System Engineers review this database as part of their System Health Reporting and consider it for potential applications. No formal response is required, as in the case of Generic Letter 88-14 and SOER 88-1, but it is incumbent upon each nuclear facility to seriously consider the applicable events listed in the database, the causes and resolutions so that similar events do not happen at their respective sites: "Operating experience; heed it or be it."

Preventative Maintenance Guide

In the mid 1990s, the nuclear industry noted that there had been challenges to the reliability of equipment essential to the production of electricity using nuclear energy. They commissioned the Electric Power Research Institute (EPRI) to assist in developing a set of Preventive Maintenance standards to support the nuclear industry. Instrument Air System components were selected to be part of the study and development of the EPRI PMIR (Preventative Maintenance Information Repository). A number of nuclear industry personnel as well as compressed air industry representatives were involved in the development of this guide. Out of this effort, in addition to a previous gathering of information involving Instrument Air System Engineers throughout the nuclear industry, EPRI produced the Compressed Air System Maintenance Guide (TR-1006677). This is an excellent resource for developing a preventive maintenance program and developing an overall understanding the Instrument Air System. The EPRI PMIR templates are used throughout the nuclear industry as a benchmarking tool in the development of preventive maintenance programs.

Conclusion

As can be noted, the nuclear industry is unique. In order to use nuclear energy safely, the nuclear industry needs to work together. Though there may be competition in the realm of selling and distributing electricity, there is tremendous cooperation between the nuclear sites: sharing "Operating experience, problems and resolutions" for the good of the industry. BP

For more information, please contact Bill Eister, Oconee Nuclear Station, Duke Energy: tel: 864-885-4572, email: wmeister@duke-energy.com

For further information:

1. *Nuclear Power Plant Illustration: By Russell D. Hoffman: http://www.animatedsoftware.com/environm/nukequiz/nukequiz_one/nuke_parts/reactor_parts.swf*

2. *Nuclear Regulatory Commission Animated Power Plant: http://www.nrc.gov/reading-rm/basic-ref/students/animated-pwr.html*

3. *In Reactors, Radiation Is Trapped and Contained in Several Ways: http://www.nrc.gov/reading-rm/basic-ref/students/radiation.html*

4. *NRC Generic Letter: http://www.nrc.gov/reading-rm/doc-collections/gen-comm/gen-letters/1988/gl88014.html*

5. *Institute of Nuclear Power Operations: http://www.inpo.info/*

6. *Regulatory Effectiveness Assessment of Generic Issue 43 and Generic Letter 88-14 (NUREG-1837): http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1837/*

7. *Nuclear Industry Organizations: http://www.nucleartourist.com/basics/inpo.htm*

SEVEN SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Project #2: Demand Control

BY THOMAS MORT, CEM

Overview

Reducing energy costs and pollution emissions involves many areas within an industrial facility. My studies have found seven key (or common) areas where low-cost, practical projects can be implemented. Combined, these projects provide savings exceeding 10% of the annual energy spend with an average payback of less than one year.

This month's article will focus on Demand Control. Electricity for most industrial facilities has two or more costs. First there is the energy cost which is measured as kilowatt hours (kWh), and then there is the demand cost measured as kilowatts (kW). Understanding the costs of these two units and also how the time of use is related is an important part of managing your energy costs. The utility term for this is Tariff Rate Schedule.

Demand Control Project Objectives

We can describe our demand control project as an effort to reduce the cost of energy by minimizing the use of electricity during the peak demand periods. Symptoms that can help identify the opportunity for a demand control project include:

1. The tariff schedule shows a demand charge and energy charge
2. The facility has equipment loads that operate less than 24 hours per day
3. The electric load profile shows demand peaks
4. There are equipment loads which can be interrupted for a period of greater than 15 minutes

Seven Key Sustainability Projects

1. Lighting
2. Demand Control
3. HVAC
4. Compressed Air
5. Metering
6. Heat Recovery
7. Project Implementation and Funding

Step #1: Gather Data

To begin an effective Demand Control project, some data needs to be gathered. First, you will need to know the Tariff Rate Schedule. This can be achieved from your utility bill, local utility representative or it is often posted on the utility websites.

From this table, we can see that though the cost of electricity is $0.102/kWh, the energy cost portion is between $0.082 and $0.066 depending on the time of day the energy is used. Also, the demand portion of the energy cost is $12.00/kW. This is the part we will focus on for this project.

Example Plant		
Energy Cost Data	USD	per unit
Average Electric Cost	$0.102	kwh
Demand Cost: 8 AM - 8 PM M-F	$12.00	kw
On-Peak cost: 8 AM - 8 PM M-F	$0.082	kwh
Off-Peak cost 8 PM - 8 AM M-F, S, S, H	$0.066	kwh

Figure 1: Tariff Table

Step #2: Understand the Demand Charge

A demand charge of $12.00/kW means that the utility company measures the electricity usage every 15 minutes for the whole month. The peak energy use of the month is called the demand and is multiplied by the $12.00 to determine the demand charge.

A demand profile, as shown in figure 2, shows the 15 minute electric readings in the form of a graph. From this graph, we can see the peak demand was 1,720 kW. This data is usually available directly from the utility company. Some utilities will give you access to see this type of detailed data from your computer at no charge and others with a small charge per month.

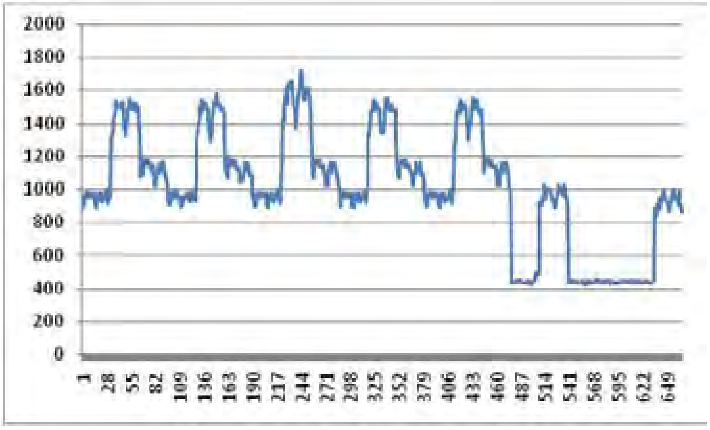


Figure 2: Interval Data

1,720 kW x $12.00 per kW = $20,640. The total electric bill was $76,512. The demand cost was 27% of the total cost! Every kW that we can reduce from this peak is worth $12.00 for each month or $144.00 per year.

Looking closely at the graph we can see that the peak occurs mid day and lasts approximately 1.5 hours. If we could reduce this peak to a maximum of 1,600 kW, we could reduce our demand by 120 kW. 120 kW x $12.00/kW x 12 months per year = $17,280 per year. This is almost 2% of our total electric spend.

SEVEN SUSTAINABILITY PROJECTS FOR INDUSTRIAL ENERGY SAVINGS

Figure 3: The data logger is installed in the equipment power cabinet

Step #3: Reduce Peak Demand by Peak Shaving and/or Load Shifting

Reducing the peak demand is often referred to as Peak Shaving or Load Shifting. The next step is to determine which pieces of equipment are causing this peak to occur. I have found that using electronic data loggers is a good way to find the guilty equipment and to have measured data to support the project.

Identify major electric-using equipment that does not run 24 hours per day. Install a data logger on the devices and record the energy usage for a period of one week. Especially look for "batch" type processes. They may only be run a few times per day or week. These are often the guilty components in causing extra peak demand charges.

Once data loggers are installed, one can get a picture of when different pieces of equipment are operating and how it relates to overall demand charges. Figure 4 shows the results of four pieces of equipment and the results are aligned with the total electric profile for the plant. The shaded bar shows the peak period when electricity is most expensive. In this example, we found a few pieces of equipment that with only a few hour changes in the operating schedule could reduce the demand charge significantly. The idea is to operate equipment outside of the peak demand period. In the beginning, the operations manager did not want to consider changing equipment schedules. After being presented with a clear graph and the dollar value, he changed the equipment schedules.

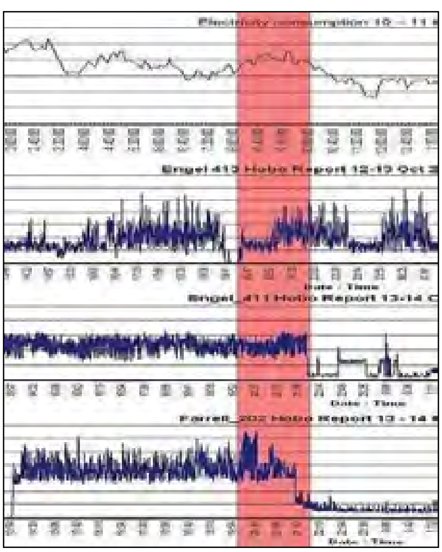


Figure 4: Equipment Load Profiles

Step #4: Demand Shaving

Another method is referred to as Demand Shaving. The idea is to find equipment that could be shut off or slowed down for a short period of time when a peak period is approaching. The type of equipment that is usually shut down or slowed down includes hot water heaters, cooling tower fans, electric ovens and air conditioning systems.

The chart in Figure 5 shows the change in the electric profile that can be accomplished by using a Demand Shaving control system. The left side of the chart shows the load profile with the control system off, and the right side shows the control system on.

Demand Shaving often requires that some automatic equipment be installed, which monitors the actual energy usage and is programmed with a set of rules to determine which equipment can be shut down or slowed down and for how long. An example of a company to review is Powerit Solutions, www.poweritsolutions.com.

There is another advantage to being able to perform Demand Shaving. Many locations in the country will pay large amounts of money to reduce your load during periods or peak demand for the utility company. Companies have formed Demand Response organizations. Often factories can receive more than $100 per kW for short period reductions in load. An example of a company that performs this service is North America Power Partners, www.northamericapowerpartners.com.

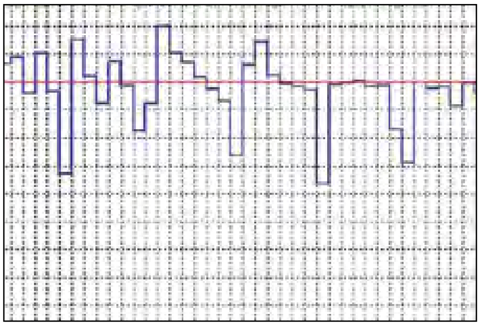


Figure 5: Demand Controller Results

Conclusion

In summary, electricity costs different amounts depending on the time of day you use it. Moving equipment to operate during the periods of lower cost can save a lot of money. Interval data is key to understanding the situation, followed by measuring the load profiles of individual pieces of equipment. BP

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THE PNEUMATIC ADVANTAGE

Preventing a Disaster
A Tutorial on Explosion-Proof Vacuums

BY PAUL R. MILLER, VICE PRESIDENT AND GENERAL MANAGER, NILFISK CFM

Power plant facilities should develop and implement hazardous dust inspection, testing, housekeeping and control procedures in order to prevent dust-related explosions. Photo courtesy of Nilfisk CFM.

In February of 2008, a sugar plant near Savannah, Georgia suffered the ultimate tragedy. Thirteen employees were killed and 40 injured when finely ground motes of sugar dust ignited, setting off a violent blast. If the fatalities and a tarnished reputation weren't enough, the Occupational Safety and Health Administration (OSHA) then fined the company more than $8 million in workplace violations related to combustible dust.

Although it took a fatal accident in a sugar plant to make combustible dust a national headline, power plants have been aware of the risk for years. In 1999, six workers were killed at the Ford Power Plant in Dearborn, Michigan after a natural gas explosion caused a secondary explosion induced by coal dust. The Michigan Occupational Safety and Health Administration (MIOSHA) concluded the secondary blast could have been prevented if there was adequate housekeeping to minimize accumulation of coal dust on horizontal surfaces[i]. Unfortunately, the Ford Power Plant wasn't the first or last industrial workplace blast; the U.S. Chemical and Safety Hazard board estimates there are on average 10 explosions, 5 fatalities and 29 injuries per year as a result of combustible dust-related incidents.[ii]

So what can be done to prevent these types of accidents in the future? In March 2008, OSHA reissued their National Emphasis Program (NEP) on combustible dust to call attention to the agency's rigorous expectations for combustible dust-related explosion prevention, which includes random unannounced audits.[iii] Although the NEP applies to all industries that handle combustible dusts, there is a particular emphasis on power plants and coal/carbon dusts due to their high risk for dust-related explosions. The program also outlines recommendations for decreasing a plant's risk of an explosion, of which include incorporating a HEPA-filtered industrial vacuum into maintenance plans. While this is indeed a smart decision, power plant facilities that handle materials classified hazardous by the National Fire Protection Agency, such as coal, must actually use a certified, explosion-proof or intrinsically safe vacuum.

Certifiable Explosion-Proof: Beware of "Dress Up"

Most power plant supervisors assume the machinery in their plants is explosion-proof, including the industrial vacuums, but as seen in multiple tragedies, this often isn't the case. In fact, using just a basic vacuum can actually add to the risk of explosion.

An "explosion-proof" vacuum (EXP) is explosion-proof to the core. This means that everything from the outer shell to the internal mechanics including the motor, switches, filters and inner chambers are grounded and constructed of non-sparking materials like stainless steel. Some industrial vacuum companies offer basic models dressed up with a few anti-static accessories and describe them as suitable for explosive material. These imposters can still create arcs, sparks or heat that can cause ignition of the exterior atmosphere and overheating that can ignite dust blanketing the vacuum.

Purchasing an explosion-proof vacuum approved by a nationally recognized testing agency such as the Canadian Safety Association (CSA) or Underwriters Laboratories (UL) will protect buyers from purchasing a poser by providing legal certification that the vacuum can be used in a particular NFPA-classified environment. It ensures every component in the vacuum from the ground up meets strict standards for preventing shock and fire hazards.

THE PNEUMATIC ADVANTAGE

Nilfisk CFM A15 Intrinsically Safe Vacuum: *Pneumatic intrinsically safe vacuums are a viable option when electricity isn't available or desired but should still meet the requirements for use in your NFPA-classified environment. Photo courtesy of Nilfisk CFM.*

Explosion-Proof vs. Intrinsically Safe

In environments where electricity is unavailable or undesirable, air-operated vacuums for hazardous locations are excellent alternatives. It is important to note that only electric vacuums can be certified and deemed "explosion-proof," but properly outfitted pneumatic vacuums referred to as "intrinsically-safe" can pack the same punch as their electric counterparts while still meeting the requirements for use in NFPA-classified environments. Plant managers should beware of vacuum companies that refer to their pneumatic models as "certified explosion-proof." Explosion-proof certification for air-operated machines simply does not exist.

Filtration

Superior filtration does not have to be sacrificed on an explosion-proof model, especially when collecting potentially hazardous material like coal dust. For peak safety and operating efficiency, an EXP vacuum should have a multi-stage, graduated filtration system, which uses a series of progressively finer anti-static filters to trap and retain particles as they move through the vacuum. In order to eliminate combustible dust from being exhausted back into the ambient air, a HEPA or ULPA filter can be positioned after the motor to filter the exhaust stream. Quality HEPA filters offer an efficient, effective way to trap and retain the smallest dust particles, down to and including 0.3 microns. An ULPA filter captures even smaller particles, down to and including 0.12 microns.

An ignitable material, an ignition source and oxygen — all it takes for a potential explosion at your facility. Most manufacturing plants have all three. In 2006, fatalities involving explosions and fires increased by 26% in the manufacturing sector according to the Bureau of Labor Statistics Census of Fatal Occupational Injuries. In addition to injuries, explosions cost companies millions of dollars. Between 1992 and 2002, Factory Mutual Global's pharmaceutical and chemical clients experienced dust explosions resulting in $32 million in losses. OSHA has estimated that there are approximately 30,000 U.S. facilities at risk for combustible dust explosions. Simply put, there's a lot of stake.

NFPA 654 (Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids) contains comprehensive guidance on the control of dusts to prevent explosions. The following are some of its recommendations:

Spill Response

Spill response should also be taken into account when purchasing an explosion-proof vacuum. Although OSHA's National Emphasis Program is specifically looking at companies that handle dry solids, manufacturers' maintenance plans are also under the microscope. If workers might need to collect flammable or explosive chemicals, a wet-model, explosion-proof vacuum should be considered which is also available in both electric and air-operated versions.

Conclusion

It is only a matter of when, not if, OSHA will initiate enforced standards for combustible dust procedures, and with power plants being at the top of the agency's watch list, facilities can guarantee they'll be seeing an OSHA agent on their doorstep in the near future. Purchasing a high-quality, explosion-proof or intrinsically safe vacuum is a solid first step in preventing a combustible dust-related explosion, and picking the right vacuum often raises a lot of questions, especially when it comes to disaster prevention. Like all investments, pre-sale research is key. Plant managers shouldn't hesitate to ask the vacuum manufacturer for an onsite analysis of their vacuum needs in order to recommend what type of explosion-proof vacuum, hose and accessories are needed for the application. With the right equipment, the vacuum can be used to collect dust and debris from the floor, machinery, walls and even overhead pipes and vents. Naturally, every manufacturer will be responsive to your needs before you buy, so look for a company that will still be there after the bill is paid. Excellent post-sale support and training will make things easier when it's time to purchase replacement parts and filters or service the vacuum.

- Minimize the escape of dust from process equipment or ventilation systems
- Use dust collection systems and filters
- Utilize surfaces that minimize dust accumulation and facilitate cleaning
- Provide access to all hidden areas to permit inspection
- Inspect for dust residues in open and hidden areas, at regular intervals
- Clean dust residues at regular intervals
- Use cleaning methods that do not generate dust clouds if ignition sources are present
- Only use vacuum cleaners approved for dust collection
- Locate relief valves away from dust hazard areas
- Develop and implement a hazardous dust inspection, testing, housekeeping and control program (preferably in writing with established frequency and methods)

THE PNEUMATIC ADVANTAGE

If used consistently and in conjunction with a comprehensive maintenance plan, the facility's investment in an explosion-proof vacuum will result in much more than just a clean plant; it will save money, protect company integrity, increase productivity and most importantly, protect the most valuable asset — the employees.

BIO:

Paul R. Miller is vice president and general manager of Nilfisk CFM. He has more than 20 years of experience in the industrial vacuum cleaner industry, serving in various capacities throughout his tenure with the company. As a former sales representative, product manager and director of operations, Miller has seen firsthand the unique maintenance challenges manufacturers face, developing effective and efficient solutions for their dust and debris problems.

About Nilfisk CFM:

Nilfisk CFM, the industrial vacuum division of Nilfisk-Advance America, helps its industrial customers meet their individual cleaning requirements and challenges with an extensive range of high-performance vacuum cleaners. From its Malvern, PA headquarters, Nilfisk CFM provides industrial vacuums for heavy-duty applications that require maximum suction power and specialty vacuums for clean applications that demand "absolute" air purity and facility cleanliness. The company's vacuums are equipped with industry-specific features and exceptionally efficient filtration systems, ensuring dust- and debris-free facilities in the food, chemical/pharmaceutical, electronics, metalworking/powder coating and a variety of manufacturing industries. For more information, visit www.no-more-dust.com or call 1-800-645-3475. BP

i "CIS Reaches Historic Settlement Agreement with Ford and UAW." Department of Energy Labor and Economic Growth. 02 Jan 2008. <http://www.michigan.gov/dleg/0,1607,7-154-10573_11472-52301--,00.html>.

ii "Investigation Report: Combustible Dust Hazard Study." U.S. Chemical Safety and Hazard Investigation Board. 02 Jan 2008. <http://www.csb.gov/completed_investigations/docs/Dust%20Final%20Report%20Website%2011-17-06.pdf>

iii "Combustible Dust National Emphasis Program." Occupational Health and Safety Association. 02 Jan 2008. <http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3729>

PERSONAL PRODUCTIVITY

Why Leaders Fail
When the Best Strategies Can't Get It Done

BY JOHN BAKER

A recent study reported in the Harvard Business School Press found that only one in 10 large company CEOs achieve their growth targets. Considering the enormous amount of time and resources spent annually creating the perfect strategic plan, these results point to a fundamental and expensive gap between leaders who create strategic plans and the people who are expected to execute them. Why is it, then, that leaders who boldly set robust agendas designed to inspire their people and dominate their marketplace far too often end up licking their wounds in defeat before the year is out?

While each situation differs to some degree, consider these four common reasons good strategies don't always lead to good results:

1. The "I'm the boss, so it will get done" fallacy.

When the job title gets in the way of reality, failure is sure to result. The label on your business card — CEO, president, VP, director, senior manager, whatever — clouds a lot of perceptions. No matter how highfalutin a strategy is — demonstrating brilliance and shrewd marketplace acumen — execution of the plan is only as probable as the tightest bottleneck in the system. Do you want to win? If so, find where the business process is in constraint and focus your company's resources to alleviate the logjam. The old adage, "a chain is only as strong as its weakest link," is as true in business as it is in life.

The best business strategy balances aspiration with perspiration. The humbling part of being a leader is that your fate — and the fate of your organization — lies in the hands of the least amongst your team. This doesn't mean a leader can't be forward-looking and motivational. An essential responsibility of a leader is to enlarge the organizational dialog to include expansive aims and aggressive targets. The irony, though, is that your performance is more closely tethered to the slowest-moving member of your team than to your expansive aspirations and best strategies.

The "strategy-to-execution" process breaks down when the strategy is an ego-stroking, leader-centered document rather than one that clearly defines the value the company provides both internally to the entire team and — more importantly — to external customers.

The most important question for a leader isn't, "What do I want to do?" but rather, "What can we get done working together?"

PERSONAL PRODUCTIVITY

2. It's about throughput not input.

Laying out an aggressive agenda sounds good to senior managers, shareholders and Wall Street, but ultimately it's what comes out the end of the pipe that matters, not what you cram into the front of it. The rank-and-file — those chartered to interpret the strategy and take action — look at broad, sweeping strategic plans with rolled eyes and deep sighs of dejection. When the corporation concentrates on creating fancy strategic plans — leveraging high-priced outside consultants, spending time on executive offsites and assembling impressive looking SWOT charts — the practical issue of individual capacity is left on the sideline.

Imagine a doctor in the ER looking strategically at a trauma victim. Examining the patient the doctor thinks to herself, "I need to set that arm, stabilize the blood pressure, stop the bleeding in the chest, keep the airway clear, ensure the patient is on a good nutrition program, takes a daily multi-vitamin, gets started on a smoking cessation program and enrolls in an anger management counseling."

This approach to medical care would lead to disastrous results. Instead the doctor pays attention to the most critical element of treatment and solves that first. Once stabilized, attention is allocated to the next priority. In business, too many strategic plans take a "kitchen sink" approach to the business priorities, ensuring that a little bit of everything gets done but nothing gets completely done.

The most important question in the strategic plan: "Can we do all of this, and if we can, what do we do first?"

3. It's not about execution; it's about focus.

How many times have you heard a leader state, "We have the right strategy, but we can't execute"? The fact is that without focus, any organization — from a football team to a huge multi-national corporation — will fail to achieve its goals. Generally, people do what they are rewarded to do. When there is confusion, the essential connection between the strategic plan and the work that gets done is critically compromised.

The most impressive, albeit painful, way to gain focus is to go into crisis. Look at the heightened focus a crisis delivers to an organization. People immediately get on the same page, the value of the work is clearly perceived, teamwork is highly valued and individuals perform at peak levels.

Some organizations operate using crisis management as a way to get things done. This is insane and unsustainable, but how do you drive focus into an organization without sacrificing rational and stable business practices? You must teach your organizations where it is okay to fail: What tasks are imperative to the health of the company and which ones — though important — can be compromised?

This is difficult to do because failure is not traditionally taught in leadership courses. "Failure is not an option," is a quip that has become part of our cultural lexicon. Not knowing where you are willing to fail means not being serious about success. Leaders must uncompromisingly communicate the critical path to success and do so at the individual level. Distractions abound, setbacks occur and deviation from the strategic plan happens before the ink on the document is dry. The organization that knows how to "mind its business" is the one that delivers on its vital promises.

The most important question to ask about execution: "What is your focus?"

> "A recent study reported in the Harvard Business School Press found that only one in 10 large company CEOs achieve their growth targets."

4. Not knowing how to define success.

This seems odd given that the strategic plan is all about illuminating a path to success, but when success has multiple definitions, there is neither a cohesive nor a unifying message for the organization. Worse yet, if you cannot define success internally, the chances of defining it for your clients are dramatically reduced.

The bias, of course, is to measure success with reams of financial data. This is essential, as the DNA of a business is defined in numbers. Yet, numbers can do poor justice to the process of defining success. They can provide conflicting evidence of success, be internally focused to a fault and provide information on past performance rather than an accurate prediction of future outcomes.

A vital job of a leader is to be able to decipher the difference: management is the collection of data; leadership is creating organizational action.

The most important question to ask when defining success: "Are we successful, and if we are, how do we know?"

Leaders fail because no matter how outstanding the strategic thinking, which is typically generated at the top of an organization, it is only as good as it is understood and executed at every level in the organization. BP

John Baker is author of the newly released book, READY Thinking — Primed for Change. As a leadership expert, speaker and founder of READY Thinking, LLC, John has helped hundreds of organizations achieve success by adopting a practical framework of thinking during times of change and opportunity. He has more than 20 years experience as a senior executive with companies including American Express and Ameriprise Financial, specializing in sales, client loyalty and customer service. For more information, e-mail JohnBaker@ReadyThinking.com or visit www.ReadyThinking.com.

RESOURCES FOR ENERGY ENGINEERS

TRAINING CALENDAR

TITLE	SPONSOR	LOCATION	DATE	INFORMATION
Energy Management	Atlas Copco	Charlotte, NC	2/10/09	Tel: 336-725-2395 (Jessica)
Compressed Air Challenge® Fundamentals of Compressed Air	Southern California Edison, California Energy Commission, DOE EERE	Irwindale, CA	3/3/09	Adriana Chavez tel: 626-812-7563 Adriana.chavez@sce.com www.compressedairchallenge.org
Compressed Air Challenge® AIRMaster+	PG&E, California Energy Commission, DOE EERE	San Francisco, CA	3/10/09	Cheryl Boswell Barnes tel: 209-932-2500 cjb9@pge.com www.compressedairchallenge.org
Energy Management	Atlas Copco	Chicago, IL	3/11/09	Tel: 847-981-8995 x200 (Giuliana)
Compressed Air Challenge® Fundamentals of Compressed Air	Hughes Machinery, Omaha Public Power District, Atlas Copco, DOE EERE	Omaha, NE	3/24/09	Dennis Tribble tel: 402-571-5004 dtribble@netexpress.net www.compressedairchallenge.org
Compressed Air Challenge® Advanced Mgmt. of Compressed Air	Hughes Machinery, Omaha Public Power District, Atlas Copco, DOE EERE	Omaha, NE	3/25/09	Dennis Tribble tel: 402-571-5004 dtribble@netexpress.net www.compressedairchallenge.org
Compressed Air Challenge® Fundamentals of Compressed Air	Sacramento Municipal Utility District, California Energy Commission, DOE EERE	Sacramento, CA	4/7/09	Nancy Kenney tel: 417-455-5402 Kenney-n@mssu.edu www.compressedairchallenge.org
Compressed Air Challenge® Fundamentals of Compressed Air	Hughes Machinery, Alliance for Bus. Education Missouri Southern State Univ. Atlas Copco, DOE EERE	Joplin, MO	4/15/09	Nancy Kenney tel: 417-455-5402 Kenney-n@mssu.edu www.compressedairchallenge.org
Compressed Air System Technical Seminar	Total Equipment Company	Coraopolis, PA	4/29/09	Chuck Gerbe tel: 412-269-0999 chuckgerbe@totalequipment.com
Compressed Air Challenge® Fundamentals of Compressed Air	PNM, DOE EERE	Albuquerque, NM	9/10/09	Carmen Chico tel: 505-241-4404 Carmen.Chico@pnm.com www.compressedairchallenge.org
Energy Management	Atlas Copco	Seattle, WA	5/20/09	Tel: 206-244-3818 (Rawleigh)

Editor's Note: If you conduct compressed air system training and would like to post it in this area, please email your info to rod@airbestpractices.com

PRODUCT PICKS

New ShopTek™ Air Compressors

Sullair Corporation announced the availability of its new ShopTek™ lubricated rotary screw air compressor. These economical, efficient, reliable compressors combine Sullair's proven rotary screw technology in a compact belt-drive package that establishes new standards for continuous-duty compressors to meet the needs of small horsepower markets.

Sullair ShopTek™ compressors are available in eight models ranging from 5–20hp, with capacities from 17–78 acfm and pressures from 125–175 psig. All models are available with an optional Performance Air System that includes a Sullair dryer and Sullair filter. An 80 or 120 gallon storage tank completes the Performance Air System package. The ShopTek™ air compressor is simple to install with a small footprint for better utilization of floor space. It also features a durable enclosure that reduces sound levels as low as 66 dBA and is easily removed for routine maintenance procedures. The conveniently located control panel provides access to an integrated full voltage starter. The advanced ST Controller helps match output to demand and monitors the status of key operating parameters.

Sullair Corporation
Tel: 219-861-5089
Email: judi.seal@sullair.com
www.sullair.com

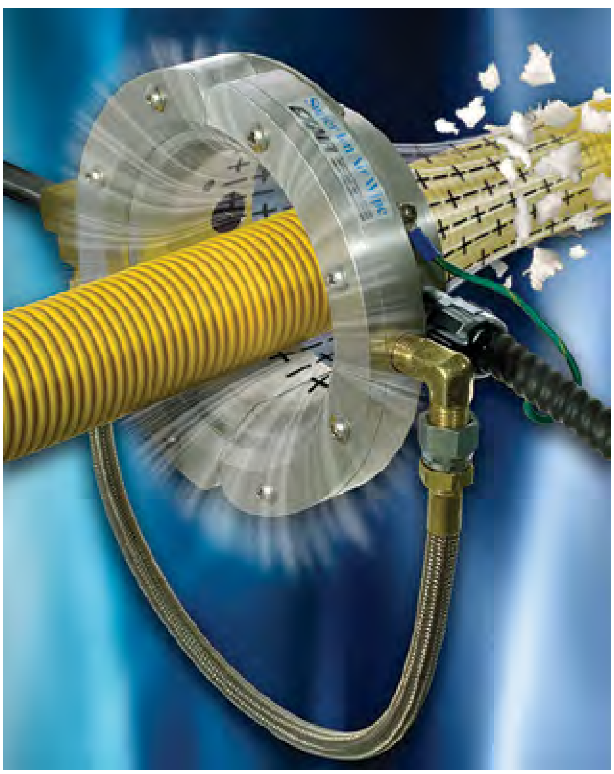
RESOURCES FOR ENERGY ENGINEERS

PRODUCT PICKS

Industrial Vacuum Provides Savings

The Nilfisk CFM SL vacuum series, which include the 3SL, 5SL and 5WSL, meet the twin concerns of cost and performance, featuring solid construction and strong performance at an affordable price. Lightweight and highly maneuverable, the SL Vacs are ideal for picking up powders, liquids, dust and debris. Featuring all the "bells and whistles" of higher-priced industrial vacuums, they are also available with HEPA filtration to capture 99.97% of particles, down to and including 0.3 microns. A unique release lever that lowers the wheeled collection container also makes disposal of collected debris a breeze. Like all Nilfisk CFM vacuums, the SL series is compatible with the company's comprehensive line of hoses and accessories to suit a wide range of cleaning applications.

Nilfisk CFM
Tel: 610-647-6420
www.stop-the-dust.com



360° Static Discharge and Cleaning for Moving Surfaces

EXAIR's new Super Ion Air Wipe provides a uniform 360° ionized airstream that clamps around a continuously moving part to eliminate static electricity and contaminants. It is ideal for removing dust, particulates and shocks on pipe, cable, extruded shapes, hose, wire and more.

The Super Ion Air Wipe uses a small amount of compressed air to entrain high volumes of room air. Two shockless ionizing points powered by a UL Listed 5kV power supply fills the airstream with static eliminating ions. That airflow attaches itself to the surface of the material running through the air wipe and is effective for many feet away from where it is mounted. The force of the wiping action can be controlled with an optional pressure regulator. Effective static neutralization will be produced with 5 psig. Higher pressure produces a more forceful wiping action and is most effective for high-speed processes and over long distances.

The Super Ion Air Wipe has an aluminum construction that is lightweight and easy to mount using the tapped holes provided. Two sizes include a 2" (51mm) diameter that has an air consumption of 30 scfm and a 4" (102mm) with an air consumption of 50 scfm when powered at 80 psig. There are no moving parts to wear out. Prices start at $747.

EXAIR Corporation
www.exair.com/78/siaw.htm
Tel: 800-903-9247

PRODUCT PICKS

Energy-Efficient Vacuum Pump

PIAB presents its P5010 vacuum pump for optimizing and enhancing handling processes in the secondary manufacturing in the packaging line of consumer goods. Featuring patented COAX® cartridge technology and designed for automated product handling applications, the P5010 pump gives the highest possible vacuum performance in relation to energy consumption, helping to reduce carbon footprint and improve conservation efforts.

The modular P5010 design guarantees shorter changeover time and provides opportunities to customize and optimize vacuum performance, function and interface. Featuring two base pumps and strong aluminum interfaces, the P5010 is highly energy-efficient, lightweight, robust and reliable.

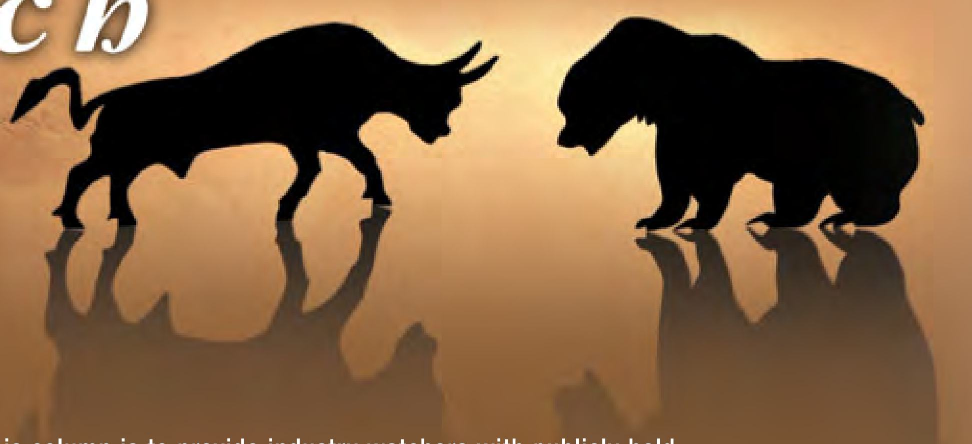
"Consumer packaged goods (CPG) are often difficult to handle due to various shapes and porous packaging materials, which can allow vacuum leakage between the suction and product surface. This leakage can lead to dropped products, line stoppages and reduced efficiency," said Josef Ramslov, Business Unit Manager for Consumer Goods Industry at PIAB. "The three-stage cartridges inside the P5010 pump create more initial vacuum flow, which translate into a faster response and more reliable product handling in leaking and high-speed applications."

To further reduce energy consumption, the P5010 series can be equipped with an optional air-saving (ES) function. Further, a control unit (CU) with valves for on/off and blow-off activation caters to the needs of packaging and manufacturing companies that handle porous products, such as paper and corrugated cardboard. The blow-off is essential to clean pipes, filters and surfaces from dust in handling applications. The adjustable blow-off flow-capacity also enables the appropriate usage of force based on product weight to prevent damage, product loss and improve process control. These two options can also be combined with a digital display (an additional Automated Vacuum Management AVM 2) to further reduce the risk of personnel injuries and unnecessary scrap.

PIAB North America
Tel: 800-321-7422
Email: info@piab.com
www.piab.com

Wall Street Watch

BY COMPRESSED AIR BEST PRACTICES™



The intent of this column is to provide industry watchers with publicly held information, on publicly held companies, involved with the sub-industry of compressed air. It is not the intent of the column to provide any opinions or recommendations related to stock valuations. All information in this column was gathered on January 12, 2009.

JANUARY 12, 2009 PRICE PERFORMANCE	SYMBOL	LAST PRICE	1 MONTH	6 MONTHS	12 MONTHS
Parker-Hannifin	PH	$40.99	14.2%	-38.7%	-36.5%
Ingersoll Rand	IR	$18.66	28.1%	-42.4%	-49.0%
Gardner Denver	GDI	$23.81	-0.4%	-54.8%	-20.3%
United Technologies	UTX	$52.18	7.9%	-13.2%	-26.8%
Donaldson	DCI	$32.30	3.4%	-22.7%	-20.6%
EnPro Industries	NPO	$20.40	5.1%	-41.6%	-20.4%
SPX Corp	SPW	$39.68	28.0%	-64.2%	-53.0%

MINNEAPOLIS (Nov. 24, 2008) — Donaldson Company, Inc. (NYSE: DCI) announced first quarter FY09 diluted earnings per share ("EPS") of $0.60, up 13% from $0.53 last year. Net income was $48 million, up 11% from $43.3 million last year. Sales were $573.3 million, up 9% from $525.6 million in the first quarter of FY08.

"We are very pleased to start our new fiscal year with another record performance," said Bill Cook, Chairman, President and CEO of Donaldson Company, Inc. "Continued strength in our aerospace and defense, industrial filtration and gas turbine businesses helped to offset weakness in our other end markets. Our sales grew 14% in Asia, 11% in the Americas and 4% in Europe."

"Our operating margin performance was very good at 12.2%, equal to the same period last year and well above our minimum target of 11%. We did experience higher raw material costs early in our first quarter, which we have worked to offset through a combination of pricing actions with our customers and our internal cost reduction efforts. These efforts continue."

"While we had a solid start to our new fiscal year, we also foresee a challenging global economic environment in front of us. As a result, we have been proactively managing our business and working aggressively to reduce our expense levels. Our progress to date is evident as our operating expenses decreased to 20.4% of sales this quarter compared to 22% in the fourth quarter of FY08. We expect that the combination of our continued focus on operating expense controls, product and process cost reductions and the strength of our diversified portfolio of filtration businesses will allow us to achieve our 20th consecutive year of record earnings."

"We recognize that it is critical that we successfully manage through the current difficult economic climate. However, it is important to note that we also remain focused on our longer-term strategic objectives. Our recent acquisition of Western Filter was part of these plans."

Hamilton, Bermuda, December 18, 2008 — Ingersoll-Rand Company Limited (NYSE:IR), a leading diversified industrial firm, today announced that it has revised its estimated fourth-quarter adjusted diluted earnings per share (EPS) to the range of $0.20 to $0.30 from continuing operations. This earnings estimate excludes non-recurring costs such as those related to the acquisition of Trane and restructuring costs. Management's previous EPS estimate for the fourth quarter of 2008 was $0.55 to $0.75 from continuing operations. Full-year adjusted EPS from continuing operations are preliminarily projected to be in the range of $3.00 to $3.10 per share, before Trane related acquisition and restructuring costs, compared with a prior forecast of $3.35 to $3.55 per share.

"Our initial forecast for the fourth quarter of 2008 was based on sharply lower growth expectations compared with the first half of the year as we anticipated weaker results in many of our key end markets," said Herbert L. Henkel, chairman, president and CEO of Ingersoll-Rand Company Limited. "The rate of decline accelerated compared with prior expectations. We had lower than expected revenues in all of our business segments, primarily due to softer North American and sharply declining Western European markets. The rate of deterioration in European economic activity was especially severe over the last six weeks. The strengthening of the U.S. dollar against the Euro also amplified the year-over-year revenue decline.

WALL STREET WATCH

"Projected fourth-quarter proforma revenues are expected to decrease by 11% compared with 2007, to $3.7 billion, which is approximately 10% below our initial forecast of $4.1 billion and includes approximately two percentage points of negative impact from currency translation. Lower volume, unfavorable mix, and several one-time cost items are negatively impacting operating earnings for the quarter. Additionally, the increased value of the dollar is expected to negatively impact earnings by approximately $0.15 per share compared with our prior forecast for the quarter.

"We have accelerated our previously announced productivity actions for the balance of the year and for 2009 to deal with the slowing environment while continuing to build a strong business for the future. We are realizing the synergies from the recent acquisition of Trane and from our initiatives in purchasing and Lean Six Sigma, which will produce even greater benefits in 2009. We expect the Trane acquisition synergies to exceed $75 million in 2008 and we are on track to realize an additional $125 million in 2009. We are also targeting to capture significant material cost reductions in 2009 from the recent sharp declines in key commodities.

"During the fourth quarter we initiated corporate-wide restructuring actions that we announced in October to streamline our manufacturing footprint and general and administrative cost base. The majority of these costs will be incurred in 2008 and are expected to total approximately $110 million. These actions are expected to generate $100 million of annual pre-tax savings in 2009 and over $110 million in 2010. We have accelerated the timing of the restructuring and are developing additional cost reduction actions to offset declining end markets.

"We continue to generate positive cash flow and we have sustained access to the commercial paper markets. Since the acquisition of Trane in June, we have paid down approximately $600 million of debt. We have significant available liquidity with $3 billion of credit facilities, as well as additional opportunities to access the cash on our balance sheet, expand our receivable securitization program and improve our working capital management.

"Additionally, the company is currently conducting its annual impairment test of goodwill and intangible assets which, because of the company's recent low stock price, could result in a non-cash impairment charge in the fourth quarter. Any potential impairment charge will not impact our existing debt covenants or our borrowing capacity under current credit arrangements. Our long-term business fundamentals remain solid and we are working to ensure that Ingersoll-Rand will emerge from this economic slowdown as a stronger, more efficient company," said Henkel.

NEW YORK, Dec. 11, 2008 — United Technologies Corp. (NYSE: UTX) President and CEO Louis R. Chênevert affirmed the company's expectation for 2008 earnings per share growth of 15%, or $4.90 per share. Chênevert also projected 2009 earnings per share of $4.65 to $5.15, a range of plus or minus 5%. The company anticipates 2008 cash flow from operations less capital expenditures in the range of net income.

"Continued strength in our aerospace and defense, industrial filtration and gas turbine businesses helped to offset weakness in our other end markets."

— Bill Cook, CEO, Donaldson

"UTC expects solid results in 2008 with 15% earnings per share growth," said Chênevert. "Strength in our long cycle businesses and benefits from early cost reduction actions should more than offset adverse impacts from the stronger U.S. dollar and rapidly deteriorating end markets in the second half of the year.

"We expect difficult and uncertain economic conditions through much of 2009. We are confident UTC's strong global franchises and experienced management team will continue to outperform even in this environment. We anticipate that further deployment of our ACE operating system, continued focus on cost controls and benefits from early and substantial restructuring actions taken in 2008 will help offset significant foreign currency related headwind on earnings in 2009. All six operating divisions are expected to expand margins in 2009," Chênevert continued. "Liquidity is not an issue at UTC and we continue to expect cash flow from operations less capital expenditures to equal or exceed net income in 2009. These strong cash flows, coupled with continued access to the commercial paper market and low levels of long-term debt maturing over the next year, give us confidence that we can continue our acquisition agenda along with our share repurchase program."

UTC revenues are expected to decrease to approximately $57 billion in 2009 as the adverse impact from foreign currency translation will more than offset expected low, single digit organic growth. UTC's backlog remains strong at approximately $57 billion. BP

COMPRESSED AIR BEST PRACTICES™ MAGAZINE

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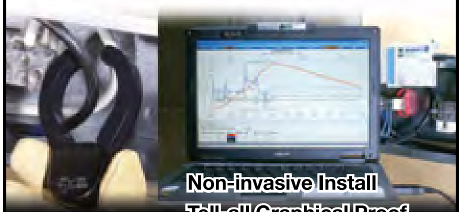

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