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March 2010

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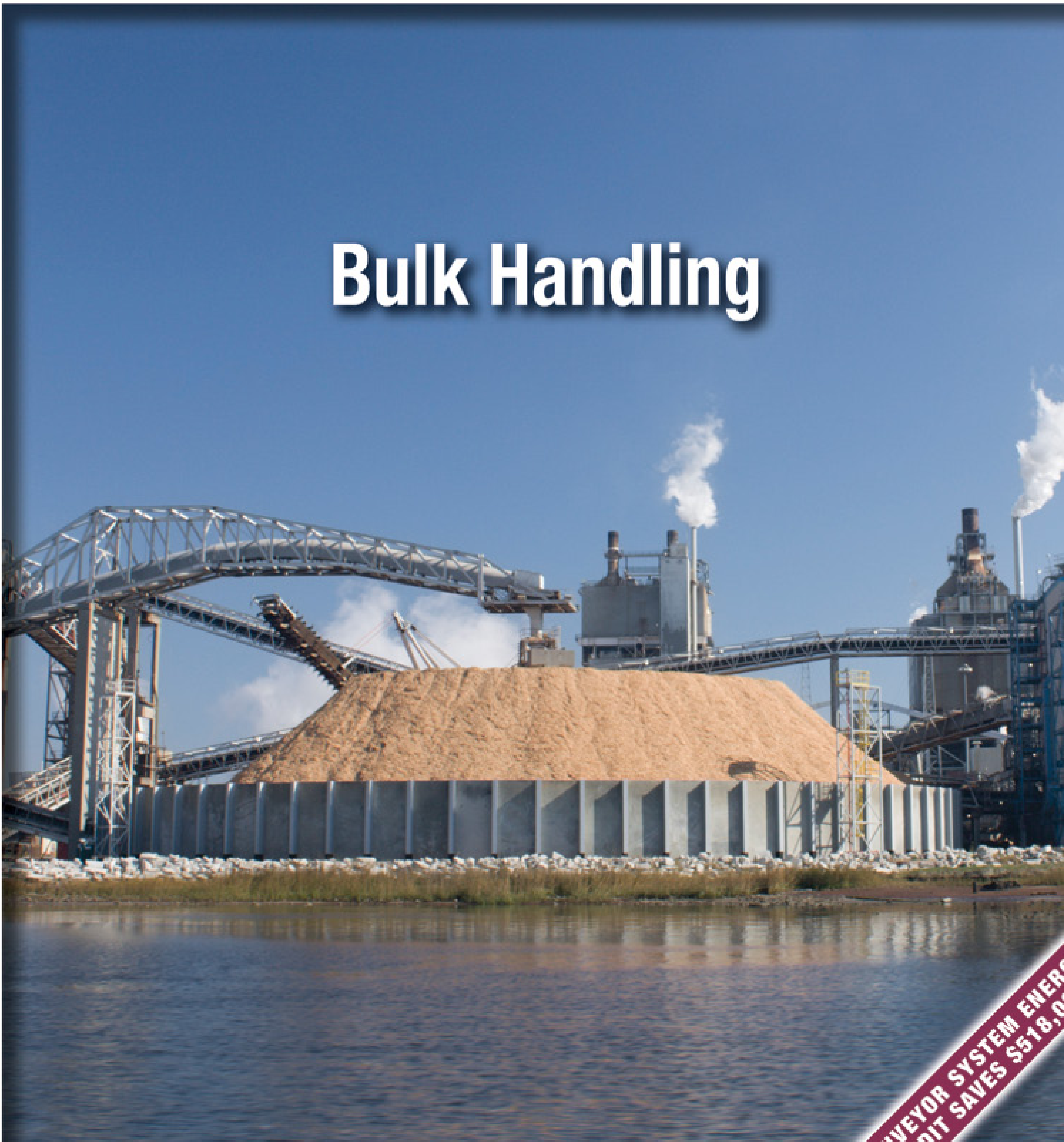

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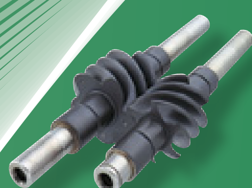

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HITACHI
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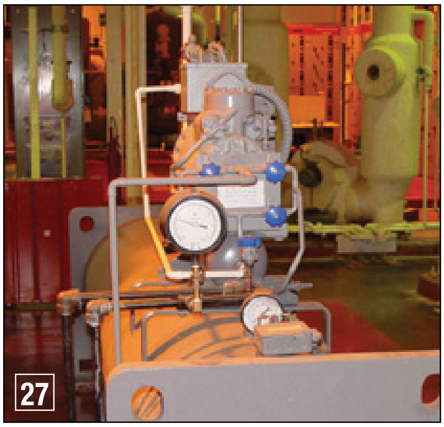
SUSTAINABLE MANUFACTURING FEATURES



COLUMNS

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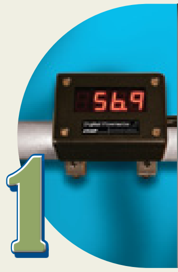

1

EXAIR's **Digital Flowmeter™** accurately measures compressed air usage and monitors waste. Trends can be monitored to find excessive air use. Detects leaks at compressed air fittings when the machinery is off. Regular monitoring can detect leaks that develop as the machinery ages.

- **Easy to install - No adjustments or calibrations needed**
- **Digital readout displays actual airflow through pipe**

www.exair.com/78/4dfm.htm

2

EXAIR's **Ultrasonic Leak Detector** can help you identify costly leaks in your compressed air system. Leaks can account for 30% of total compressor output! In many cases, finding one small leak can quickly pay for the leak detector.

- **Detects leaks up to 20' (6.1m) away**
- **Accurate in noisy industrial environments**

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3

EXAIR's award winning **Super Air Knives™, Super Air Nozzles™,** and **Super Air Amplifiers™** entrain large volumes of room air using only a small amount of compressed air as the power source. They dramatically reduce air consumption and noise.

- **Low cost - Replaces noisy blowers**
- **Improves blowoff performance and safety**

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4

EXAIR's **EFC™** is an electronic flow control that minimizes compressed air use by turning off the compressed air when no part is present. For use on blowoff, drying, cooling, conveying and static elimination operations.

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- **Photoelectric sensor withstands water and dust**

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5

An EXAIR 60 gallon **Receiver Tank** can be installed at the point of high demand so there is an additional supply of compressed air available for a short duration. Meets ASME pressure vessel code.

- **Eliminates fluctuations in pressure and volume**
- **Vertical, space saving design**

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6

EXAIR **Pressure Regulators** permit easy selection of an operating pressure that will allow the air product to work properly without using excessive amounts of compressed air. Reducing the air pressure from 100 PSIG to 80 PSIG reduces energy use by almost 20%.

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FROM THE EDITOR

New Web Site Launch at www.airbestpractices.com

This edition is loaded with valuable information — but readers beware — it might require some extra concentration! The topics are arguably the most important, yet they are also the hardest to master. Two important articles in this edition include truly understanding compressed air demand and evaluating the efficiency of your distribution piping when delivering compressed air. Most factories and many, many "advisors" are not strong in understanding these topics. The Compressed Air Challenge® and Gary Wamsley from JoGar Energy Services provide us with two excellent hands-on articles dealing with these issues.

In the System Assessment of the Month, Hank Van Ormer supplies us with an interesting audit story on how a pneumatic conveying system was optimized for significant energy savings.

This month, we have also written an article called "Innovations at Ingersoll Rand". I had the opportunity to visit Charlotte, NC and witness IR's product launches for the new R-Series Contact-Cooled Rotary Screw Compressors and the Centac C-1000 Centrifugal air compressor. I was energized (along with almost 700 IR sales people) and learned quite a bit. After all the acquisitions and divestitures of the past two years, it seems clear that IR is ready to begin their next chapter in the compressed air systems business.

We hope you have had the opportunity to visit our newly launched web site at www.airbestpractices.com. Designed for end users and industry professionals alike, it makes available the past four years worth of valuable content. Articles are organized in seven main sections: Industries, Energy Manager, System Assessments, Sustainability Projects, Energy Incentives, Technology and Standards.

We hope that compressor salespeople will utilize this resource. For example, they might look under the "Standards" section before visiting a food processing facility to find relevant air quality standards for the food industry or system optimization ideas.

We also hope that end users will refer to the site for ideas on how to reduce their energy costs and/or improve their compressed air systems. The "Industries" section has 13 sub-categories for 13 different industries. From wastewater to automotive, our case studies are there for energy managers to read and hopefully find ideas and motivation to implement their own compressed air system optimization projects.

We hope you enjoy this edition, and thank you again for your support and for investing in Industrial Energy Savings. BP

ROD SMITH
Editor
rod@airbestpractices.com

SUSTAINABLE MANUFACTURING NEWS

Caraustar, Georgia-Pacific, Kimberly-Clark

SOURCED FROM THE WEB

The Caraustar® Commitment to Sustainability

Caraustar has been committed for more than 70 years to recycling and to the manufacture of 100% recycled paperboard products. Caraustar recovers 2.4 million tons of paper fiber each year. In the past five years, Caraustar Mills have:

- Reduced carbon emissions by 21.9%
- Reduced energy per ton by 14.6%
- Reduced water per ton by 18.9%

Caraustar's Recovered Fiber Group developed a program to collect and recycle used, damaged, obsolete and over-issued books for conversion into recycled paper products. We collected 18,000 tons of books in 2008.

Caraustar uses Lean manufacturing practices and Kaizen events to improve efficiencies and reduce plant waste. In one plant, an event yielded a 43% reduction in make-ready time and, in another plant, we reduced waste on a line by 30%.

Caraustar uses vegetable and soy inks for the majority of our offset and flexographic printing, reducing the amount of volatile organic compounds (VOCs) released into the environment. We have installed inking systems on our presses that control the consumption of ink and reduce the amount of ink waste by 20%.

Caraustar packaging engineers analyze customer's structures and substrates to provide sustainable packaging alternatives, while meeting or exceeding specifications. Our packaging engineers redesigned one structure for a customer, which reduced the paperboard consumed by 45%, and reduced greenhouse gases by over 40%.

We have also introduced a fourth paperboard grade — ES paperboard (Environmentally Smart) made entirely of recovered fiber — with a minimum of 50% post consumer waste.

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SUSTAINABLE MANUFACTURING NEWS

Caraustar, Georgia-Pacific, Kimberly-Clark

Georgia-Pacific Embraces Energy Efficiency, Uses Green Power

Energy efficiency has always been a priority at Georgia-Pacific, and today Georgia-Pacific facilities self-generate enough energy to meet more than half the company's annual energy needs. As an added benefit, much of that energy is generated from burning renewable biomass fuels, such as bark, wood residue and by-products from the wood pulping process.

Georgia-Pacific is not content to stop there. Today, the company is engaging in new energy initiatives that address everything from natural gas and electric lighting to energy inventories and alternative energy solutions.

Natural Reduction

To reduce rising natural gas costs and improve air emissions, employees at Georgia-Pacific's Green Bay, WI, Broadway consumer products mill created a hybrid-drying process by rebuilding a paper machine that was using 12-year-old drying technology. Employees developed a hybrid-drying hood that reduces natural gas consumption by capturing and re-circulating high-temperature and humid exhaust air back into the drying unit. The patent-pending process saves the mill hundreds of thousands of dollars a year in natural gas costs and reduces energy use by one million British thermal units (Btu's) per ton — the amount of energy needed to heat more than 900 homes. Broadway employees won the Wisconsin Governor's 2006 Pulp and Paper Energy Efficiency Award for their work.

Also focused on reducing natural gas consumption, Georgia-Pacific's Camas, WA, paper mill participated in an energy-saving assessment as part of Save Energy Now, a United States Department of Energy initiative.

Shining the Light on Energy Savings

The Georgia-Pacific procurement group is leading an energy initiative to upgrade lighting at many Georgia-Pacific facilities, replacing older, less-efficient fluorescent and metal halide lighting. Although the effort requires a significant initial investment, it has the potential to reduce power consumption anywhere from 30–50% at each facility where lighting upgrades are made. The lighting program will be implemented at almost 50 Georgia-Pacific facilities.

European Facilities Optimize Energy

Energy costs are the second largest cost, after wood and wood fiber, at Georgia-Pacific's International Consumer Products mills. To better understand and improve energy efficiency, Georgia-Pacific launched the Energy Optimization Project, designed to communicate to employees the need to save on energy, and to identify opportunities for improvement.

Two years later, the European operations have made significant progress. For example, at the Nokia, Finland, facility, energy consumption was cut almost 60% with an improved vacuum system for water removal before drying, while at the Cujik plant in the Netherlands, several projects, including insulation of hot water and steam pipes, have improved energy efficiency. All of these practices are being shared.

Georgia-Pacific facilities in Turkey and Italy also have invested in cogeneration turbines, which combine heat and energy to avoid waste. The savings in gas and electricity are estimated at 20–25%.

Kimberly-Clark Establishes Vision 2010

Vision 2010 sets out specific environmental objectives and focus areas. These reflect the most significant environmental concerns identified by the United Nations Environment Program and the World Business Council for Sustainable Development that affect our business: energy use, climate change and the availability of clean water.

Energy Use

In 2008, we used 76.4 trillion Btu's of energy, approximately 20.7% of which came from renewable sources. These include wood waste and spent liquor from our two pulp mills.

We measure energy efficiency by calculating the energy used per metric ton of production. In 2008, energy efficiency improved by 4.5% to 14.8 million Btu (MBtu) per metric ton of production, compared with 15.5 MBtu/metric ton in 2007.

Every facility enters quarterly energy use data into our global sustainability database so we can track progress. Our global Energy Services Team supports those facilities furthest from achieving their targets, and helps regional energy coordinators to implement energy efficiency improvement plans.

ENERGY USE BY TYPE (TRILLION BRITISH THERMAL UNITS)

	2005	2006	2007	2008
Natural gas	27.4	27.7	27.8	28.4
Electricity	21.0	20.3	20.7	20.3
Fuel oil	3.6	2.2	2.0	2.2
Coal	9.5	11.0	10.8	9.2
Steam/other	14.9	14.0	13.2	11.3
Self-generated liquor	5.1	4.6	4.6	4.9
Other self-generated	0.1	0.1	0.1	0.1
Total energy use	**81.6**	**79.9**	**79.2**	**76.4**

SUSTAINABLE MANUFACTURING NEWS

Caraustar, Georgia-Pacific, Kimberly-Clark

ENERGY EFFICIENCY (MILLION BRITISH THERMAL UNITS PER METRIC TON OF PRODUCTION)

	2005	2006	2007	2008
Actual	16.2	15.8	15.5	14.8
Annual target*	14.5	14.5	14.0	13.8
Percent deviation from Vision 2010 targets	12.0%	9.5%	11.1%	7.5%

*Based on the process benchmarks and the relevant year's production

ACTUAL GREENHOUSE GAS EMISSION FROM MANUFACTURING – CO_2-E* (MILLION METRIC TONS)

	2005	2006	2007	2008
Carbon dioxide (CO_2)	5.95	6.04	6.13	5.93
Methane (CH4)	0.02	0.02	0.02	0.01
Nitrous oxide (N_2O)	0.04	0.04	0.04	0.04
Total CO_2-e**	**6.01**	**6.10**	**6.19**	**5.98**

* 2005-2007 restated based on the most recent emission factors from the U.S. Environmental Protection Agency Climate Leaders Program.
** We have no known emissions of Perfluorocarbons (PFCs) or Sulfur hexafluoride (SF6). Our emissions of Hydrofluorocarbons (HFCs) on an annual basis are 0.001 million tons.

DIRECT AND INDIRECT GREENHOUSE GAS EMISSIONS FROM MANUFACTURING – CO_2-E (MILLION METRIC TONS)*

	2005	2006	2007	2008
Indirect	3.30	3.29	3.39	3.31
Direct	2.71	2.81	2.80	2.67
Total	**6.01**	**6.10**	**6.19**	**5.98**

* 2005-2007 restated based on the most recent emission factors from the U.S. Environmental Protection Agency Climate Leaders Program.

GREENHOUSE GAS EMISSIONS FROM MANUFACTURING, NORMALIZED TO PRODUCTION (METRIC TONS OF CO_2-E PER METRIC TON OF PRODUCTION)

2005	2006	2007	2008
1.25	1.24	1.24	1.16

In 2008, each of our consumer product mills in North America and Europe finalized a three-year energy plan to help them reach their Vision 2010 goals. These plans include investment in new equipment as well as operational and maintenance changes. Other significant projects completed in 2008 include:

- In Jaromer, Czech Republic, our mill implemented a program to convert process fan drives to more energy efficient models by 2010, ultimately saving 18,600 million Btu and reducing annual energy costs by more than $150,000
- In Paris, Texas, we completed a three-year compressed air improvement program, achieving annual savings of over 15,000 million Btu and over $400,000. Some examples of these improvement measures include replacing old and inefficient dryers with a high- efficiency dryer, installing central air control storage tanks, along with a high-speed pressure control valve to control system pressure swings and prohibiting the use of compressed air for machine and floor cleaning.

Climate Change

We have held meetings with all business units to review their growth plans through 2015. We used these data to project emissions for each business and for the company as a whole, with a view to setting a corporate carbon emissions target, which we plan to report in 2009.

Our business and facility managers are responsible for compliance with governmental and corporate climate change requirements, led by our Global Senior Leadership Team (GSLT). The corporate environment, health and safety and energy departments help business units to implement measures and report their progress to management.

We are committed to reducing our greenhouse gas (GHG) emissions by increasing energy efficiency at our manufacturing sites and through the distribution of our finished products. This is one of the focal points of our Vision 2010 program.

We calculate our emissions using factors endorsed by the U.S. Environmental Protection Agency Climate Leaders Partnership and based on the Greenhouse Gas Protocol developed by the World Business Council for Sustainable Development and World Resources Institute. Our mills in Europe use the approved factors of the European Union Emissions Trading Scheme.

We have a system in place to calculate and track carbon dioxide equivalent (CO^2-e) emissions from fossil fuels consumed at K-C facilities, as well as from purchased electricity. We also track emissions generated through finished product distribution in the U.S. We track both our absolute emissions and emission intensity per metric ton of production.

GHG emissions from manufacturing decreased from 1.25 tons of carbon dioxide equivalent CO^2-e per unit of production in 2005 to 1.16 in 2008, a 7% reduction. BP

Kimberly-Clark

Environment · Energy · Health · Safety
VISION2010
Leading the way for a sustainable future

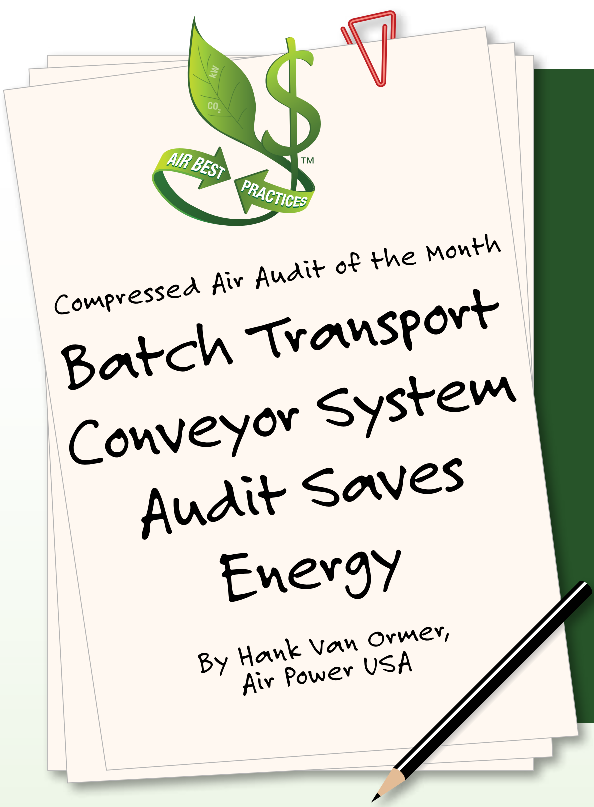
THE SYSTEM ASSESSMENT OF THE MONTH

Batch Transport Conveyor System Audit Saves Energy

BY HANK VAN ORMER, AIR POWER USA

A compressed air system assessment saved this building materials manufacturer over $518,000 per year in energy costs, with a simple ROI of 11 months. Optimizing centrifugal compressor controls, replacing the air dryers, reducing air demand and installing a dedicated low-pressure compressed air system were the actions taken to achieve the results. Please note that due to article length constraints, this article only covers the portion of the system assessment dedicated to the installation of the low-pressure system. To achieve the savings numbers, all portions of the system assessment were executed.

The system assessment discovered that 2700 scfm of 105 psig compressed air was supplying the pneumatic batch transport conveyor system and the twelve air rings supporting the production lines. The energy savings solution was to deploy a dedicated low-pressure compressed air system designed at <55 psig. This portion of the audit project delivered savings of $298,000 and energy savings of 3.1 million kWh.



March System Assessment of the Month

Where:	Western United States
Industry:	Building Materials
Issues:	Misapplied High-Pressure Air
Audit Type:	Supply Side

System Assessment Win/Win Results*

Reduction in Compressed Air Use:	1,692 scfm
Approximate Annual Energy Savings:	$517,546
Investment:	$954,555
Utility Incentive Rebate:	$481,339
Net Investment:	$473,216
Simple ROI:	11 months

*Annual energy consumption

March System Assessment of the Month

Compressed Air System Before Assessment

Operating Hours:	8232 hours
Power Cost kW/h:	$0.09677
Avg. Air Flow:	12,842 cfm at 105 psig
Electric Cost per Unit of Air:	$173.03 per cfm per year
Annual Compressor Energy Cost:	$2,108,729
Annual Dryer Energy Cost:	$74,598
Total Annual Energy Cost:	$2,183,327

Compressed Air System After Assessment

Operating Hours:	8232 hours
Power Cost kW/h:	$0.09677
Avg. Air Flow at 100 psig:	8,450 cfm
Electric Cost per Unit of Air at 100 psig:	$171.03 per cfm per year
Avg. Air Flow at 49 psig:	2,700 cfm
Electric Cost per Unit of Air at 49 psig:	$86.45 per cfm per year
Annual Compressor Energy Cost:	$1,617,586
Annual Dryer Energy Cost:	$48,195
Total Annual Energy Cost:	$1,665,781

Overall System Description

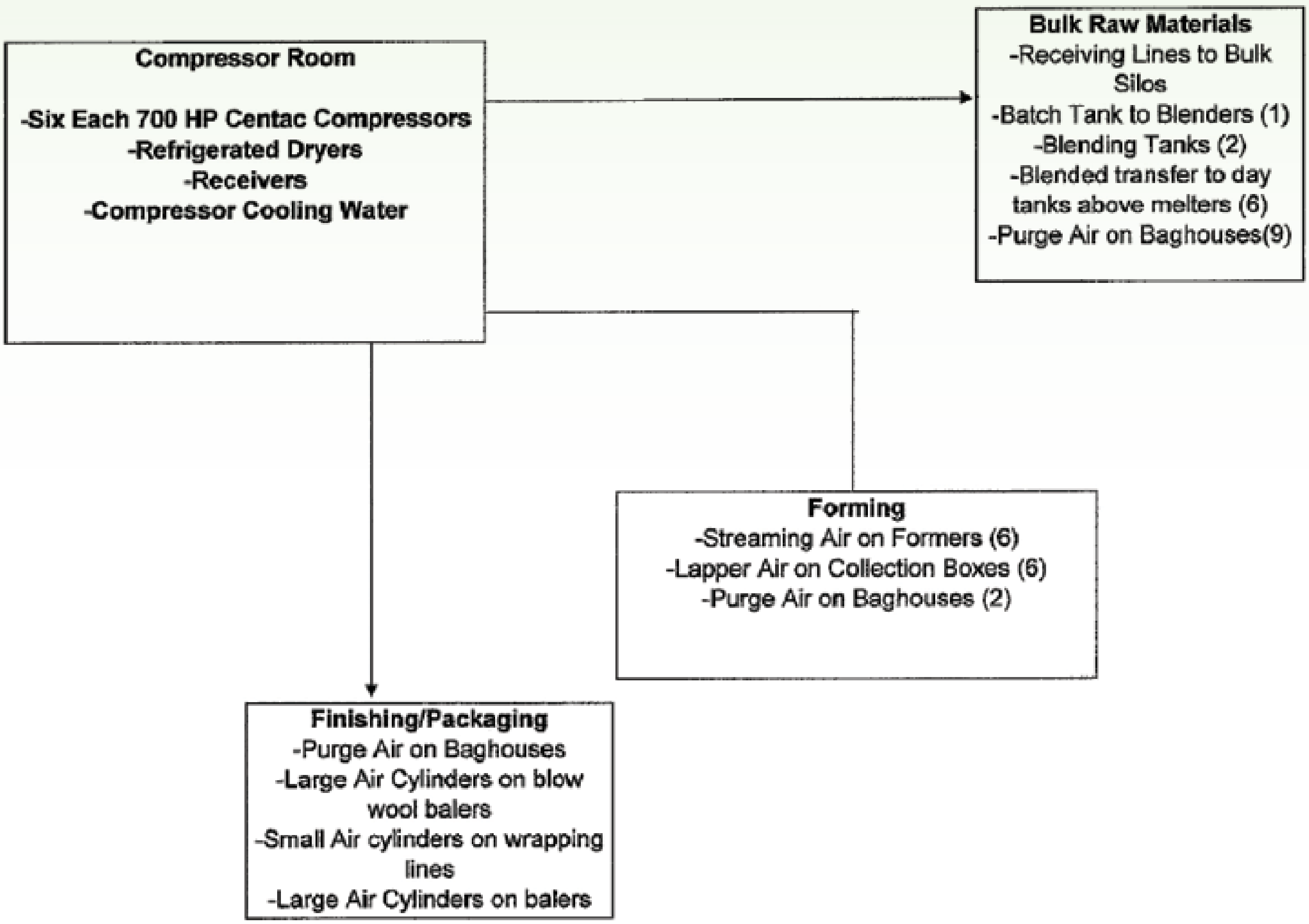
This facility produces insulation materials used in the building and construction industry. The plant runs 24 hours a day, seven days a week, with the exception of about 22 days per year (528 hours per year) for planned maintenance and repairs. Basic production is 8,232 hours per year. The blended electrical energy cost is $0.09677 kWh. This rate is expected to increase next year, as the contract with the current negotiated rate will expire.

There are two primary production lines and each line has three production modules. At full production, all six modules are operating. Typically, there are five out of six modules in production with four or more compressors running. With the sixth production module on, there are usually five compressors running with the sixth compressor needed only once in awhile.

The single largest surge demand appears to occur when all the transport systems come on simultaneously. This surge in demand appears to be in the range of 1,500–2,600 cfm.

THE SYSTEM ASSESSMENT OF THE MONTH

Batch Transport Conveyor System Audit Saves Energy



Current Compressed Air System Description

All the air compressors at the plant are 3-stage centrifugal units manufactured between 1985 and 1996. Units one through five all have 700 horsepower motors and inlet guide vanes. The sixth unit is also a 700 hp machine, and is the 1996 unit with more turn-down capabilities. A CCC controller and a target-pressure compressed air management system control all the units. All six units are well maintained and are going into blow-off once in a while. There is a tendency to run one extra unit on line because as the system demand spikes, plant personnel often cannot get fast enough response time to avoid production problems. Total scfm rated flow capacity at 110 psig is 17,894 scfm.

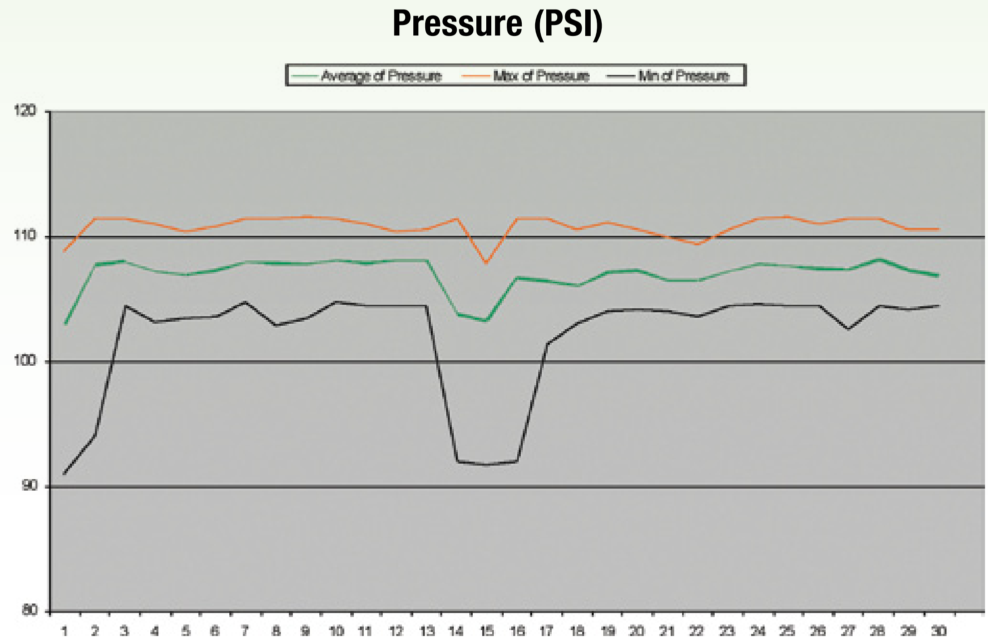
The compressed air is dried to a nominal 50 °F pressure dew point by two 6,250 scfm- rated chiller-type refrigerated air dryers and one 7,500 scfm-rated chiller-type refrigerated air dryer. Total scfm-rated drying capacity is 20,000 scfm @ 100 psig (100 °F inlet air conditions).

Measurement Actions Taken

The following actions were taken to establish baseline measures for flow and pressure:

1. Temperature readings were obtained on all units using an infrared surface pyrometer. These were observed and recorded to correlate to the unit's performance, load conditions and integrity.
2. Flow, kW and pressure for all the compressors was analyzed using the logged data provided by the plant's in-house data CCC monitoring system.
3. Pressure readings were taken, including air compressor inlet and discharge, with Ashcroft digital test gauges.
4. Discussions were held in detail with the appropriate operation in various units.

Transport System Creates Peak Surge



There is a significant surge demand event (2,700–3,800 scfm) from simultaneously running all sections of the transport system and fire ring system that often results in significant pressure pull down due to slow air supply response time. The pull down is from 110 psig–92 psig (18 psid). Other sections of the CCC data sets show pull downs as low as 78 psig (32 psid).

The peak surge occurs randomly and usually lasts 7–8 minutes. The air system apparently reacts to the transport surges at least once every 12–45 minutes by first losing system pressure and then over-pressuring on the recovery, thereby raising the system pressure, which automatically increases the consumption and reduces the flow from the compressors.

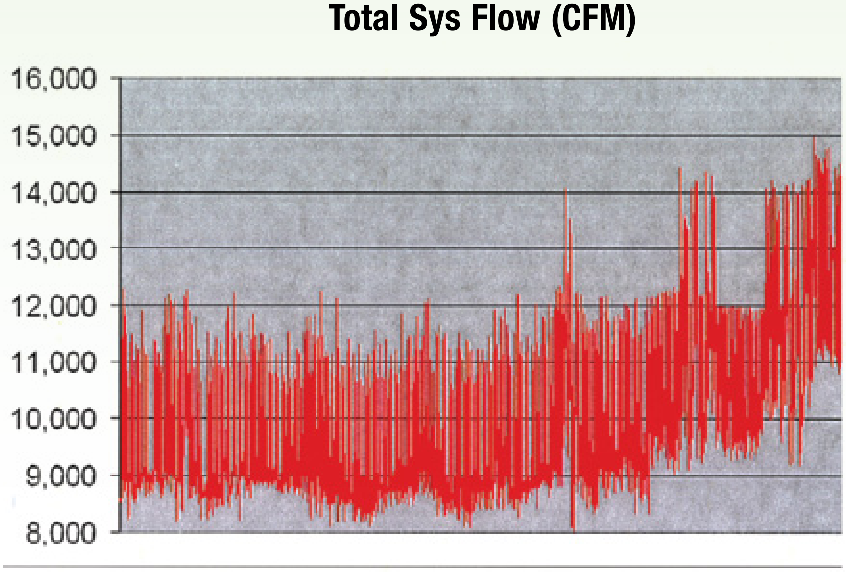
This condition is caused by the system controls not reacting to the batching air demand in a timely manner. The primary cause for this is the turbulent-generated back pressure in the interconnecting piping.

The table on the next page displays the "Total Compressor Flow". The large surge demands — upwards of 3000 cfm — are clearly visible. During the measurement period, the average compressor flow, including blow offs, was 12,730 cfm. The high variability and peaking is due to intermittent, yet significant, air demand from the transport and batch systems.

Because there is a relatively small level of blow off (224 cfm), the values for the "Total System Flow" closely approximate the air flow values for "Total Compressor Flow." During the measurement period, the average total system flow, after eliminating blow offs, was 12,506 cfm. This represents a loss of about 2% to blow offs, which is relatively low for a centrifugal compressor-based system.

THE SYSTEM ASSESSMENT OF THE MONTH

Batch Transport Conveyor System Audit Saves Energy



Misapplied High-Pressure Air

The overall strategy for improving the air system centers on the implementation of several air conservation projects, including replacing the use of high-pressure air with low-pressure air where possible. It is not efficient to use high-pressure air for very low-pressure applications.

We have identified two air flow transfer projects that currently consume 2,700 scfm in total. The projects are to convert the ring air and transport air systems from high-pressure (105 psig) to a new low-pressure (< 55 psig) system.

- Supply ring air from the new low-pressure air system = 1,200 scfm
- Supply pneumatic transporter with low-pressure air = 1,500 scfm

There are twelve "air rings" approximately 30" in diameter with 72 1⁄16" diameter holes. Each air ring is operating on high-pressure air (105 psig) reduced to 30 psig. There are two air rings in each module in the furnace area. This is a continual consumption of an estimated 100 cfm each, for a total of 1,200 scfm.

Pneumatic Transport System

This plant has an older dynamic air "dense phase" pneumatic transport system. It is a "full-pipe" type, which is designed to use low volumes of 40–50 psig air (up to 100 psig if required) to move the product through the transport conveyor piping at velocities from 100 ft/min to no more than 1,000 ft/min.

This type transport system has small "air-saver boosters" mounted along the conveyor piping to input short, small shots of air as required to control the natural solidity of the product column and to maintain appropriate compressed air pipeline velocity. The "air- saver boosters" are usually carefully set and controlled to optimize the expensive high-pressure air and not destroy the product column's solid integrity.

Because of the generally abrasive nature of the material being moved, this system was selected to eliminate or minimize transfer piping wear (8" black iron pipe) by maintaining the design's moderate velocities and still delivering an appropriate pound per hour of production. Generally, this type of system requires an air compressor of the appropriate size and pressure (35–50 psig).

The alternate choice of "dilute phase" pneumatic transport was also considered, because it is designed to run with 15 psig air, which can easily be supplied by a "blower" at a much lower electrical energy operating cost.

Dilute phase was rejected due to the highly abrasive characteristics of the product (particularly the glass and sand) and the necessary high velocities required (2,500 ft/min or more), which would create a significant transfer pipe wear problem, particularly at the elbows.

The Batch Transporter System

The pneumatic transport system fills the eight supply silos with the appropriate material to be mixed and sent on to the furnace for production. Gravity feeds the materials from the blend hold hopper in the basement. The products are then pneumatically transported to two separate "blender hoppers" through 8" lines. These are for the two production lines. From the blender hopper, the mixed batch is pneumatically transported to three "day bins" for each line, and then on to the furnace through 8" lines, as required.

At the current production levels, the batch transporter system needs to constantly handle 30,000 pounds/hour of mixture. In order to establish a two-hour cushion of supply in the day bins, the system must be capable of 90,000 pound/hour runs.

Over the years, in order to reach these required transport levels the basic system has been "adjusted", particularly the air savers or boosters. These boosters are almost all running relatively open all the time, with feed pressures from 30–90 psig as adjusted.

Today, the measured average flow through the transport system is 1,200–1,500 scfm (velocity up to 1,200 ft/min) with sustained peaks of 2,600 scfm (velocity 2,000 ft/min) for 2–3 minutes and 2,000 scfm for 6–8 minutes.

These peak surge demands appear to occur at 10–45 minute intervals, with five to six similar events throughout each hour. The deep drops in pressure are caused by a lack of available compressed air at the time (due to the somewhat convoluted interconnecting pipe) and the response time of the control system.

The Solution

The recommendation is to remove 2,700 scfm of high-pressure air demand from the system and supply it with a new low-pressure air system. This would involve the installation of three 250 horsepower, low-pressure, single-stage, lubricant-cooled, rotary screw compressors, each of which can deliver 1,500 cfm at 37 psi and have a capability of 55 psig. Then, equip each unit with a TEFC motor, NEMA4 enclosure, Wye Delta starter and turn-down control system.

The system should also include a refrigerated, cycling-type air dryer for the transport air portion. The dryer should be sized to handle 3,000 cfm at 55 psi. These units will need a closed, evaporative cooling system.

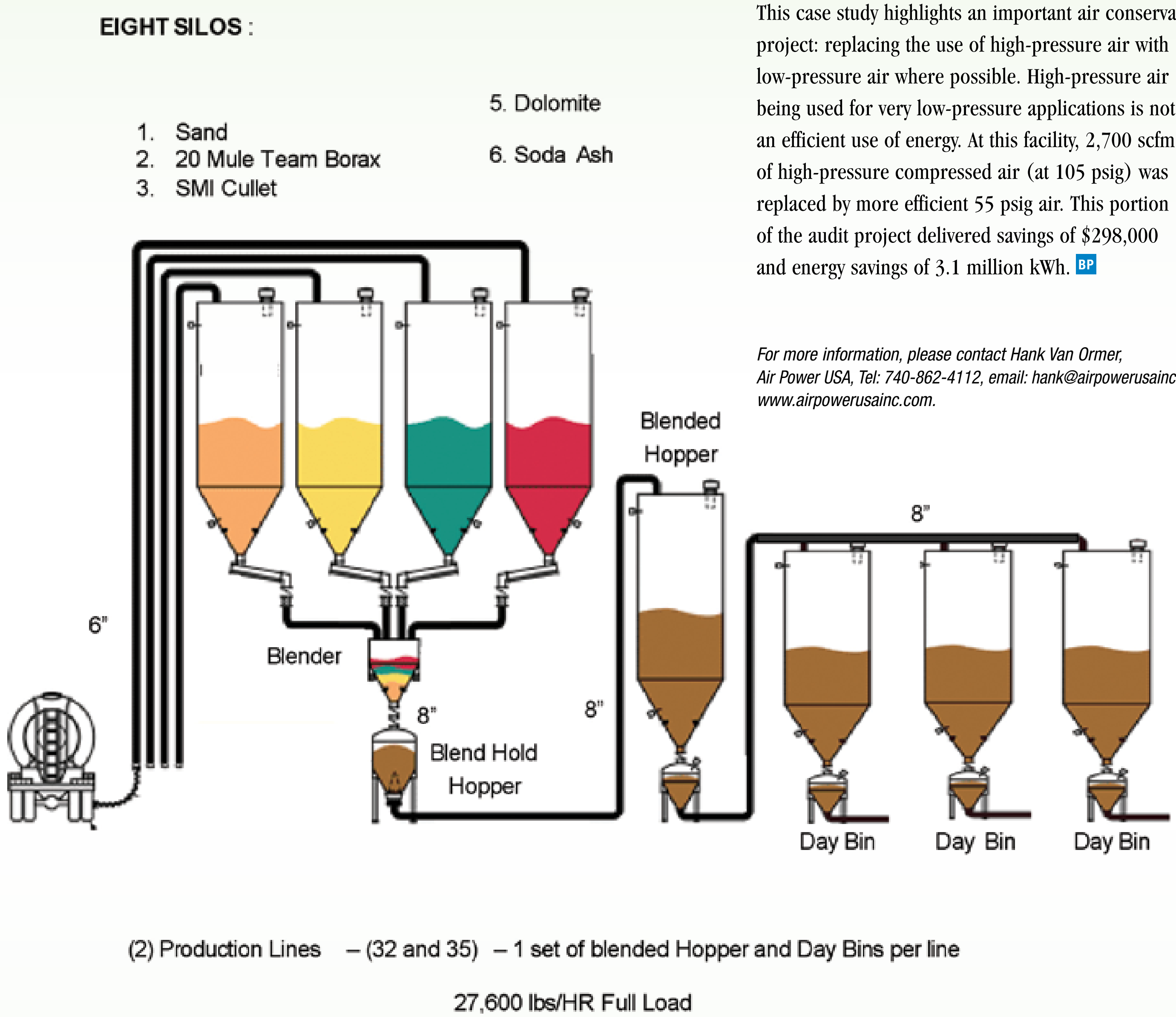
The recommendation to run the transporter system on 55 psig compressed air is based on the information supplied by plant personnel and on the record that it now runs on 35–45 psig in the primary feed lines. Some of the air boosters are also run on low-pressure air, and others use high-pressure air feeds up to 90 psig, controlled manually by the operator. This project will require proper piping from the new low-pressure air supply to the primary feed tubes, and an alternate high-pressure air supply to the "boosters" as required.

The current high-pressure compressed air system averages 2,617.6 kW for 12,842 scfm during the main production period, which is 8,232 hours per year. Of this 12,842 scfm, the batch transport system represents 1,500 scfm and the fire ring air represents another 1,200 scfm. Both of these air uses are targeted to be transferred to the new low-pressure system.

THE SYSTEM ASSESSMENT OF THE MONTH

Batch Transport Conveyor System Audit Saves Energy

Pneumatic Conveying System



Conclusion

This case study highlights an important air conservation project: replacing the use of high-pressure air with low-pressure air where possible. High-pressure air being used for very low-pressure applications is not an efficient use of energy. At this facility, 2,700 scfm of high-pressure compressed air (at 105 psig) was replaced by more efficient 55 psig air. This portion of the audit project delivered savings of $298,000 and energy savings of 3.1 million kWh. BP

For more information, please contact Hank Van Ormer, Air Power USA, Tel: 740-862-4112, email: hank@airpowerusainc.com, www.airpowerusainc.com.

THE ENERGY MANAGER

Compressed Air Piping Distribution Systems

BY GARY WAMSLEY, PE, CEM, JOGAR ENERGY SERVICES

Perhaps your facility recently had a compressed air system survey, conducted by an air systems services company, that resulted in a couple of major recommendations, such as:

- Install a new smaller compressor and new control systems on all of the units
- Repair the many air leaks (identified as 30% of your system capacity)

These capital-intensive recommendations could involve significant process system downtime, and possibly reduce air system energy costs marginally. Numerous such stories have been reported. Our experience (which includes more than 30 years of the technical evaluation of air systems from the 'users' perspective) has been that there are often more effective opportunities to evaluate, including:

- Piping system anomalies (engineering glitches)
- Equipment operational anomalies (process and maintenance glitches)

In many facilities, compressor systems often get little attention from engineering and maintenance staff because process equipment, electrical power, HVAC and steam systems normally occupy more of their time. The main technical priorities for a plant compressed air system should be:

- Manufacturing process reliability (air quality)
- Compressed air system cost control

"The higher the system air pressure, the greater the leakage."

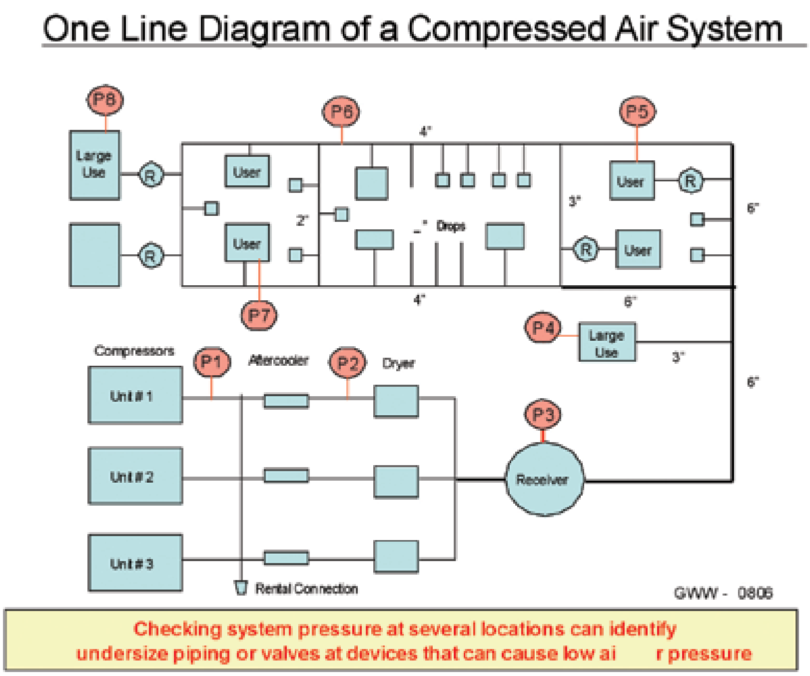
— Gary Wamsley, PE, CEM, JoGar Energy Services

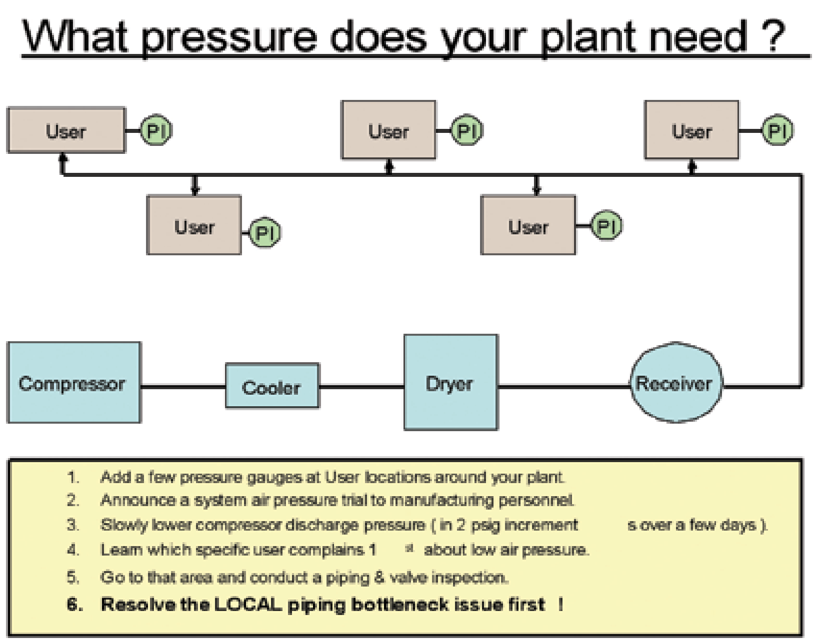
THE ENERGY MANAGER

Compressed Air Piping Distribution Systems

"Having too many compressors in service, needing equipment maintenance work, upgrading controls and repairing large leaks certainly are issues that need to be addressed. However, do not allow improperly sized air piping and fittings at one or two process machines in your plant to dictate a higher pressure for the entire system."

— Gary Wamsley





How much do you spend for compressed air?

For \$0.10 power, a 1 horsepower motor costs \$2.00 per day to operate. Two 300 hp compressors would cost about \$1,200 per day for power and \$250 per day for operation and maintenance — that equates to over \$500,000 per year.

During visits to many facilities, we've discovered production areas that have incurred air pressure problems (reliability issues) and, as a result, utilities have raised the air pressure (cost increase). **Remember the number one rule of thumb for air systems**: A 2 psig increase at the compressor is a 1% power increase on the motor. We generally recommend that plant air compressors be operated at a maximum 90–95 psig.

Will your air system support the manufacturing process at this pressure?

If not, the first order of business should be to develop a generic piping schematic diagram for use in conducting a thorough system assessment — much like having an atlas highway map for a vacation trip. Generally, every facility has a fire system schematic piping drawing because the insurance carrier requires it. You should develop a similar drawing for your plant air system. It can be extremely useful in troubleshooting and identifying anomalies.

So, what compressor discharge pressure does your facility really need? The piping system design is crucial to operating the compressors at lower pressures. Piping configuration frictional line losses can be significant. Short-duration, high 'surge-flow' conditions also can affect system pressure.

THE ENERGY MANAGER

Compressed Air Piping Distribution Systems

Perhaps your plant recently experienced a major expansion, at which point engineering surely conducted an electrical load study and a fault current assessment. Did they also conduct a compressed air piping system study before installing another compressor? Or, did they just connect the new equipment to the nearest main air line and add a new compressor in the existing machinery equipment room?

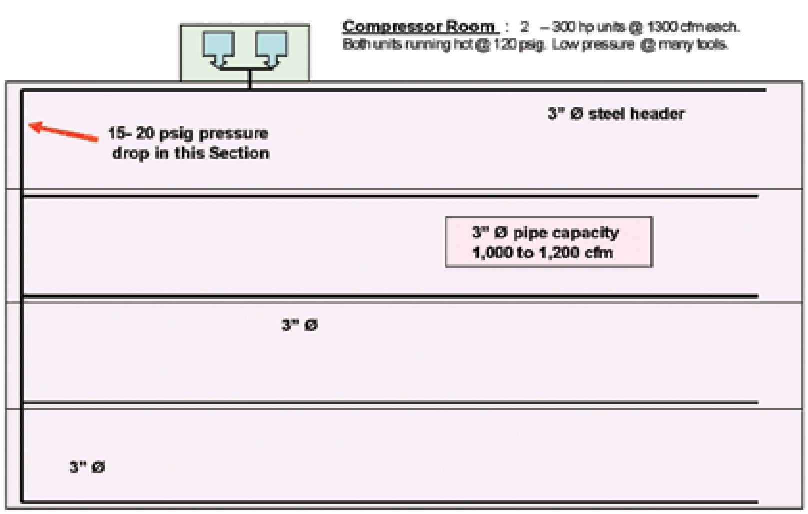
> "If your plant operates air compressors above 95–100 psig, you should know why, and have a sound technical reason for that condition."
>
> — Gary Wamsley

Consider the following actual field examples:

1. A large tissue mill in the Midwest upgraded a packaging machine and added a new high-speed casepacker. Overnight, utilities needed to run a fourth 500 hp centrifugal compressor (the stand-by unit) to ensure that the casepacker would operate properly. Our investigation discovered 150' of ¾" steel air line supplying the machine, and ½" valves and pipe nipples at the 1" size air supply regulator on the unit. A contractor crew located the nearest blank connection on the 2" air headers in the bay to supply the new equipment. Reason: The mill did not want to take a system "down" to install a 1" connection on the air line above the machine. At $0.06 power, the fourth compressor and air dryer were costing an additional $600 per day. It took about 15 minutes to convince the mill manager to schedule a two-hour "down" for an air header connection near the new machine.

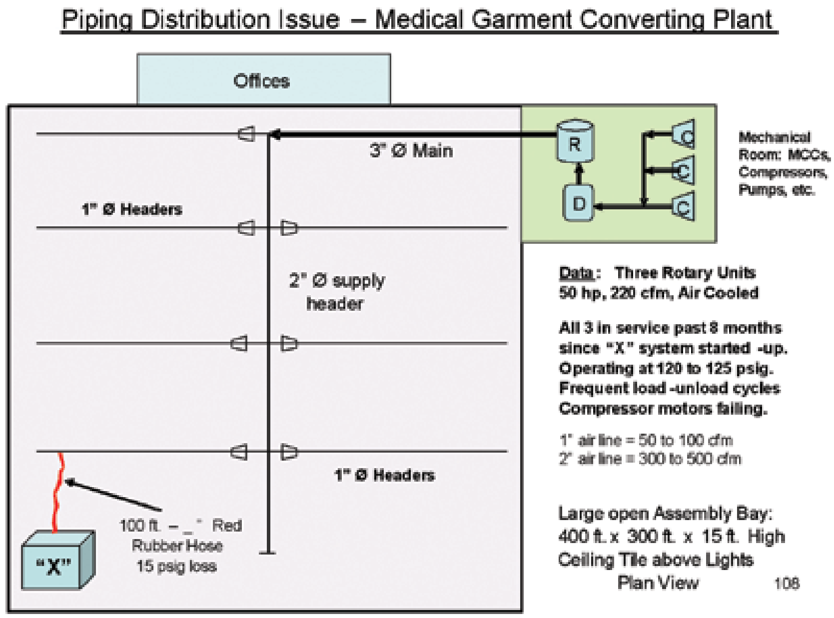
2. A steel fabrication plant had a 300 hp rotary compressor supplying air for two 500' long x 75' wide production bays. Two new bays were added adjacent to the first, and a second 300 hp compressor was installed, which sounds like a straightforward and logical plant expansion, right? Hardly! These compressors had to be operated at 125–128 psig to provide enough pressure in bays two, three and four. The process team thought that they might have underestimated air demand in the new bays, and were therefore considering a third unit. Instead, analysis identified that the 3" air line in bay one was experiencing a 20 psig pressure drop. Closing the loop at the far end of the bays allowed the compressors to again operate at 95–100 psig. A 20 psig lower pressure meant 10% savings: 40 KWh = $30,000/year. Piping cost was $15,000.

Piping Distribution Issue – Steel Fabrication Plant



4 Fabrication Bays Plan view - 500 ft. x 75 ft. x 28 ft. high

3. A healthcare garment plant in the Southwest added a new, large, automatic packaging machine at the rear its converting area. All three of its 50 hp rotary compressors were operating at 125 psig (and burning up motors). Previously, two units supplied the plant at 95–100 psig. Inspection identified 100' of ½" rubber hose supplying air to the new machine from the nearest 1" air line. A new ¾" copper line was run to the 2" main header, and the plant returned to operating two compressors at 100 psig.



4. A three-story research facility had recently installed two new development machines on the first floor. Air pressure had to be increased to 125 psig at the two 25 hp reciprocating units in the fourth floor mechanical room. The compressors were cycling 'on-off' continuously at two-minute intervals and motor failures had occurred. The 300' long, ½" copper air line running down and through the first floor equipment hallway was determined to be the issue. A second air line (¾" size) was installed to the new machines.

5. Two large 90,000 cfm pulsejet baghouses at a bronze foundry were pulse cycling continuously and bag failure rate was excessively high. We identified a ½" air line supplying the air manifold atop each baghouse structure. Air supply couplings on the manifold (provided by the vendor) were 1" size. Testing revealed air pressure drop during each pulse cycle down to 40 psig, recovering only to 75–80 psig for the next cycle. Replacing the 100' long, ½" lines with 1" size solved the problem.

THE ENERGY MANAGER

Compressed Air Piping Distribution Systems

> "A technical assessment of the piping distribution system and identifying high 'point-source' surge demand conditions should be the first order of business if low air pressure in manufacturing is a major issue."
>
> — Gary Wamsley

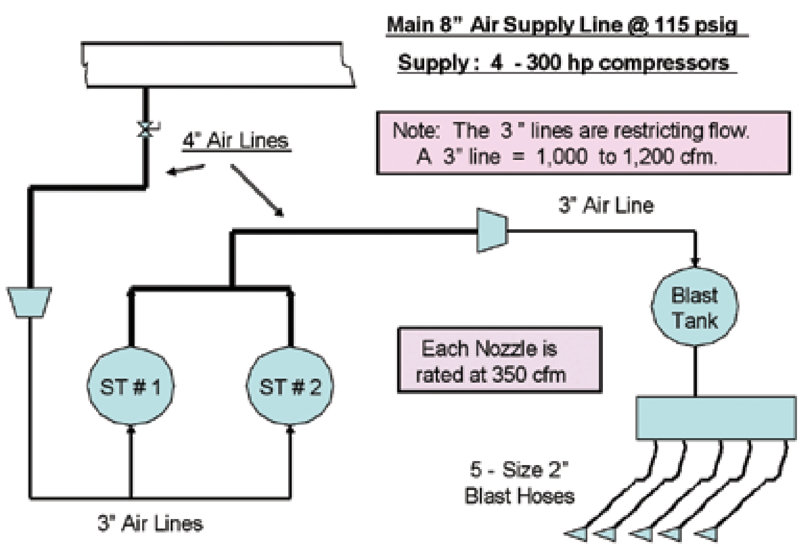
6. Two new sandblasting units were added to an existing three-unit station (to speed up the painting line) at a tank-car fabrication plant. Four 300 hp rotary units supplying the huge building were operating at 115–118 psig. Investigation identified 3" air lines to the local surge tanks and blast mix tank. Five sandblast units required 1,750 cfm of air at 90 psig. The 3" line was good for nominally 1,200–1,400 cfm. Replacing the 3" sections with new 4" pipe from the 8" main header improved blast gun performance and permitted a 10 psig lower compressor pressure.

7. Two 50 hp rotary compressors in a pharmaceutical plant packaging bay were operating at 115–120 psig, despite the 3" main air lines in the building and 80 psig pressure specification for the machines. Air line 'drops' to the six machines from the 3" main in the ceiling were 40' long, ½" size hydraulic hose. The HSE manager explained that hydraulic hose was used for employee safety reasons. New, ¾" copper pipe 'drops' solved the problem. The compressors now operate at 90–95 psig.

8. A dual-tower regenerative air dryer in the boiler plant of a paper mill was incurring a 25 psig pressure drop. Mill personnel had raised the air pressure to 110–115 psig at the two 300 hp rotary compressors to compensate. Marginally sized, 3" air header piping at the dryer towers and fouled dryer media (due to unfiltered air supplying the regenerative blower) were identified as the problem.

9. A nonwovens plant in Northern Mexico installed a new production line that increased air demand by 30%. Since capital funds for the project were tight, the project engineering team decided to use the plant 'stand-by' compressor. At start up, the three 150 hp units were operating at 120 psig, yet pressure in the plant was inadequate. The engineering team had failed to recognize that the original piping system was designed for a 'two-compressor' operation. Several piping changes at the compressors and a new 2" supply line to the expansion area were needed.

Compressed Air Supply - # 1 Sand Blast Station

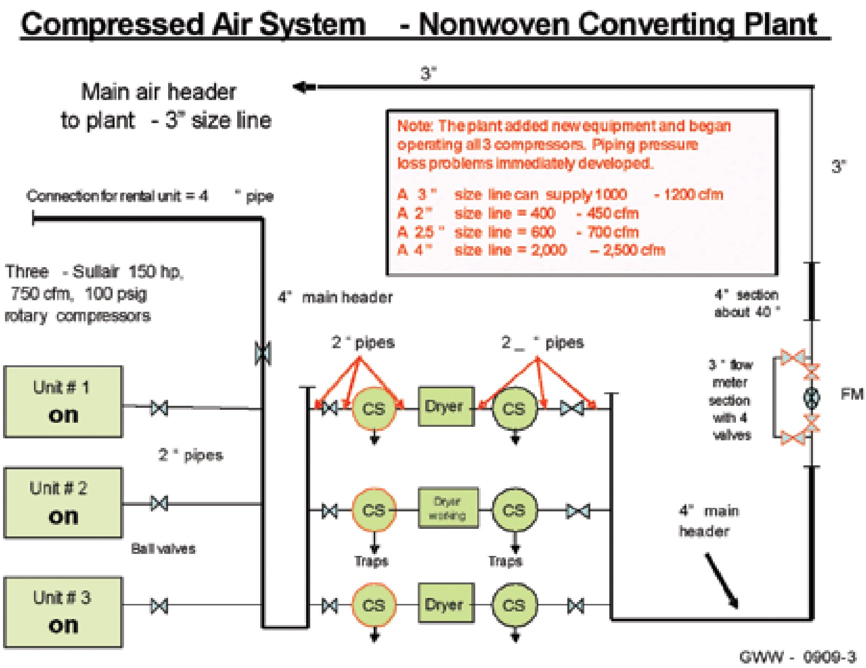


Summary and Recommendations:

If your plant operates air compressors above 95–100 psig, you should know why, and have a sound technical reason for that condition. The higher the system air pressure, the greater the leakage. Not only energy cost savings, but also long-term reliability of the compressors will result when operating at 90–100 psig versus units operating continually at 115–125 psig. Most process equipment should operate reliably with 80 psig air supply to the machine manifold (with some specific exceptions such as large air cylinders, pulse-jet baghouses and sandblast units).

A technical assessment of the piping distribution system and identifying high 'point-source' surge demand conditions should be the first order of business if low air pressure in manufacturing is a major issue. Repairing air leaks and installing additional compressors and expensive controls will not rectify a basic pipe distribution system or process machine operational issue. Having too many compressors in service, needing equipment maintenance work, upgrading controls and repairing large leaks certainly are issues that need to be addressed. However, do not allow improperly sized air piping and fittings at one or two process machines in your plant to dictate a higher pressure for the entire system. Be sure that your Compressed Air System Assessment Team flies their 'helicopter' far enough above the trees to see all of the forest. BP

For more information, please contact Mr. Gary Wamsley, PE, CEM, JoGar Energy Services, Tel: 678-977-1508, email: gary.wamsley@comcast.net or www.jogarenergy.com.



THE TECHNOLOGY PROVIDER

Troubleshooting Compressed Air Systems

BY CHRIS RAYBURN, MARKETING MANAGER, FLUKE CORPORATION

For additional research and expertise on air compression efficiency, visit the Compressed Air Challenge®

Most facilities don't prioritize the cost of operating compressed air systems — they just want to get the job done. A recent market study[1] found that only 17% of compressed air users valued efficiency as a compressed air system management goal. Nine% were concerned with containing energy costs. 71% simply wanted to deliver a consistent, reliable air supply.

Compressed air experts have noticed that many shop floor personnel behave as though compressed air is free, using it to blow excessive oil off machined parts, sawdust off woodworking devices, dust off the floor, etc. In reality, delivering compressed air requires expensive equipment that consumes large amounts of electricity and requires substantial maintenance.

The initial cost for a 100 horsepower compressor can run from $30,000 to $50,000, and it can consume $50,000 in electricity annually. At the same time, annual maintenance costs can be as much as 10% of the initial cost of a system.[2] Still, the same source reports, "[M]any facilities have no idea how much their compressed air systems cost on an annual basis, or how much money they could save by improving the performance of these systems."

For many facilities then, improving compressed air efficiency is a golden, overlooked opportunity to not only save money in energy costs, but to achieve an even more reliable compressed air supply.

First, Know Your System

In improving the efficiency of a compressed air system, it is important to view your system as just that — a system. When you change one thing in the system, that change affects everything else. For example, fixing a leak will increase the pressure in the system, making other, smaller leaks bigger. So, repairing leaks and eliminating other cases of what is called artificial demand (unproductive air use) is not a complete solution by itself. Lowering artificial demand must dovetail with strategies for improving energy use and improving your control system. The first step is to know your system, its requirements and how those requirements might be adjusted for energy savings.

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Troubleshooting Compressed Air Systems

Determine Your Operating Costs

The principal costs of operating a compressed air system are maintenance and power. Maintenance costs can be determined from your asset management system or by auditing payments to your compressed air system service contractor, if you use one.

Options for determining your system's electricity costs:

- Calculate operation running at full load, using the compressor motor nameplate rating (in break horsepower), the motor nameplate efficiency (or an estimate), annual hours of operation and cost of electricity per kilowatt-hour. Annual electricity cost is the product of these four variables[3]
- More precisely determine full-load electricity consumption and, subsequently, energy costs by using a clamp meter or multimeter to measure current and voltage into the compressor at full load
- Use a power logger to determine real power usage in kilowatts and test for power factor

Determine Demand Requirements

Estimate your compressed air load profile, in terms of how demand in cubic feet per minute changes over time. Facilities with varying load requirements can often benefit from advanced control strategies, while facilities with relatively brief periods of heavy demand can benefit from air storage options.

To establish a load profile, measure flow and pressure throughout the system under different demand conditions. Note the effect of various loading on the compressors. Significant variations in operational requirements may require a day or more of monitoring. You can use a data logger to gather and store demand profiles and power consumption profiles. This will show you when and why peak and minimal demands occur.

Record System Pressures

Use pressure gauges, a pressure/airflow meter, or a pressure module attached to a digital multimeter to take measurements at various points in the system, including:

- Compressor inlets (at the inlet filter)
- On lubricated systems, the differential across the air/lubricant separator
- The inter-stages on multistage compressors
- Pressure differentials across various components (e.g., aftercoolers, dryers, filters, etc.)

Record System Flow

Use a handheld airflow/pressure meter or a mass-flow meter to measure total flow at various places in the system and during different shifts to:

- Determine air consumption during operations
- Establish benchmarks to measure improvements against
- Estimate leak load during non-production

Log System Temperatures

Use temperature to evaluate system health. Generally speaking, equipment that runs hotter than expected is not performing optimally and needs servicing. For maximum efficiency, use an infrared thermometer to record surface temperatures of the following components:

- Aftercooler outlet temperatures — remedial action may be necessary if aftercooler outlet air exceeds the maximum inlet temperature of 100 °F
- Outlet air temperatures of rotary, lubricated compressors. Normal operations require temperatures less than 200 °F
- Inlet air temperature at compressors

Take a System Approach to Improvements

The three basic strategies for improving the performance of industrial compressed air systems are to lower artificial demand, improve control strategies and improve energy use. Keep in mind that progress in one area will likely affect the other two, making this an ongoing process.

Lowering artificial demand means repairing leaks and finding different ways to perform tasks that waste compressed air. Observe shop floor practices and look, for example, for the use of system air for cleaning parts and equipment. Then, educate personnel that compressed air is not free.

The first step in leak control is to estimate leak load. Some leakage (less than 10% of capacity and power) is to be expected, but leakage of 20–30% is both common and unnecessarily wasteful. Determine leak loads as a benchmark to compare improvements against.

Since control systems vary, so do methods for estimating leak load. If yours is a system with start/stop controls, simply start your compressor when there is no demand on the system (between shifts, or during an off-shift if your operation is not 24/7). Take several readings to determine the average time to unload the loaded system due to leaks.

Leakage (%) = (T x 100) ÷ (T + t), where:
T = on-load time (minutes)
and
t = off-load time (minutes)

In systems with more complex control strategies, place a pressure gauge downstream of the receiver and estimate the system volume (V, in cubic feet), including all secondary receivers, mains and piping. Again, with no demands except leakage on the system, bring the system up to its normal operating pressure (P1, in psig). Select a second pressure (P2, about one-half the value of P1) and measure the time (T, in minutes) it takes for the system to drop to P2.

Leakage (cfm free air) =
[(V x (P1 – P2) ÷ (T x 14.7)] x 1.25

The 1.25 multiplier corrects leakage to normal system pressure, thereby accounting for reduced leakage with decreasing system pressure.

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Troubleshooting Compressed Air Systems

Quantifying Energy Costs

In a typical United States industrial facility, generating compressed air consumes about 10% of the total electrical bill. In some cases, it's more than 30%, at an estimated cost of $0.18–$0.30 per 1,000 cubic feet of air.

Meanwhile, the efficiency of a compressed air system can be as low as 10%. For example, operating a one horsepower air motor at 100 psig requires a supply of 7 or 8 hp to the air compressor.

Suppose a manufacturing facility has a 200 hp compressor that requires 215 bhp and operates for 6800 hours annually. If it is fully loaded 85% of the time (motor efficiency = .95), unloaded the rest of the time (25% full-load bhp and motor efficiency = .90) and the aggregate electric rate is $0.05/kWh, then:

Cost when fully loaded = (215 bhp x 0.746 x 6800 hrs x $0.05/kWh x 0.85 x 1.0), 0.95 = **$48,792**
Cost when unloaded = (215 bhp x 0.746 x 6800 hrs x $0.05/kWh x 0.15 x 0.25), 0.90 = **$2,272** and
Annual energy cost = $48,792 + $2,272 = **$51,064**.

HERE'S HOW TO CALCULATE THE DOLLAR COST OF COMPRESSED AIR:

COST	=	(BHP X 0.746 X OPERATING HOURS X $/KWH X % RUN TIME X % FULL-LOAD BHP), MOTOR EFFICIENCY, WHERE:
BHP	=	Motor full-load horsepower, frequently higher than the motor nameplate horsepower
0.746	=	The conversion factor between horsepower and kilowatts
% RUN TIME	=	Percentage of time the compressor runs at its operating level
% FULL-LOAD BHP	=	bhp as a percentage of full-load bhp at the operating level
MOTOR EFFICIENCY	=	Motor efficiency at the operating level

Source: U.S. DOE Compressed Air Tip Sheet #1, "Determine the Cost of Compressed Air for Your Plant," August 2004.

Once you have this benchmark, you can find and fix leaks by using an ultrasonic leak detector that recognizes the high-frequency hissing associated with air leaks. This method of detection is faster and less messy than the old way of applying soapy water with a paintbrush to suspect areas.

The most common area for leaks is at the point of use. Pay special attention to couplings, hoses, tubes, fittings, threaded pipe joints, quick disconnects, FRLs (filter, regulator, lubricator combinations), condensate traps, valves, flanges and packings.

Improving control strategies, including adding components such as demand expanders (pressure/flow controllers) should occur in conjunction with controlling leaks and other artificial demands.

The goal is to provide the plant with compressed air at the lowest stable pressure while supporting unexpected demand with adequate high-pressure air storage. Replenishing stored air should use minimal compressor horsepower.

Monitor Compressor Use and Look For:

- Compressors running needlessly
- Compressors, other than trim compressors, running at less than full load
- Operations that fail to maintain relatively low average pressure
- Operations that sometimes deliver less than minimum system requirements

Through leak repairs and improved control strategies, you may be able to eliminate one or more large compressors (in multi-compressor systems), significantly reducing energy usage. You may also add back a small compressor to keep the system charged during low demand, and eliminate the inefficiencies of large compressors operating at less than full load. Improving energy use involves improving equipment efficiency on both the supply and demand side of the system. The efficiency of the entire system depends on the proper selection, correct installation and rigorous maintenance of each component.

On the Supply Side, Consider the Following Components:

- Your compressor(s) prime movers
- Compressor controls
- Air treatment equipment
- Dryers
- Filters
- Receivers
- Storage vessels

Also, it's easy to overlook the way air tanks handle the accumulation of condensate. Some simply let water fill up, reducing capacity and risking system damage. Others have an old automated system that opens a valve on a timed basis, whether that's necessary or not. This is basically a leak, so a better solution is a valve that opens only when needed and closes as soon as the water is removed.

Finally, size and lay out the entire system so that the total pressure drop from compressor to points of use is significantly less than 10% of the pressure at the compressor discharge.

On the Demand Side, Pay Attention to the Following Components:

- Condensate/lubricant separators
- Air/lubricant separators
- Heat recovery systems
- Point-of-use systems

"The three basic strategies for improving the performance of industrial compressed air systems are to lower artificial demand, improve control strategies and improve energy use."

— Chris Rayburn, Marketing Manager, Fluke Corporation

Tie System Performance to Production

Ultimately, increased productivity is the final measure of the success. Using the strategies described here, periodically correlate findings such as system output (cubic feet per minute at psig) and energy consumption (kilowatt hours) to units of production. In general, expect improvements to cause energy use to decrease unless production increases along with corresponding increases in compressed air loads. If production does not increase as pressure increases, adjust controls as required. BP

For more information, contact Chris Rayburn, marketing manager for Clamp Meter, Earth Ground and Insulation Test Products, Fluke Corporation, email: christopher.rayburn@fluke.com, www.fluke.com.

Notes

[1] See "Appendix D" of Improving Compressed Air System Performance: a Sourcebook for Industry, online at ***http://www.compressedairchallenge.org/library/index.*** html#Sourcebook. Study commissioned by the U.S. Department of Energy (DOE) with technical support from the Compressed Air Challenge® (CAC).

[2] Improving Compressed Air System Performance: a Sourcebook for Industry: Section 12, "Compressed Air System Economics and Selling Projects to Management", p. 69.

[3] See Ibid. Section 10, "Baselining Compressed Air Systems," p. 61, and also Section 11, "Determining Your Compressed Air System Analysis Needs."

innovation at Ingersoll Rand

BY ROD SMITH, COMPRESSED AIR BEST PRACTICES®

Ingersoll Rand (IR) has launched a new generation of rotary screw and centrifugal air compressors. The announcement was made in early February at an "Innovation Showcase" event in Charlotte, NC. An entire hotel was reserved for almost a week so that 600 to 700 Ingersoll Rand salespeople from across the Americas could be trained on the new technologies. A handful of us "media types" were also invited to come and learn about Ingersoll Rand's latest innovations in compressed air systems.

The New Ingersoll Rand

Ingersoll Rand has gone through a period where the structure of the company has changed significantly. **Jim Bolch**, president of IR's Industrial Technology Sector, said, "Over the past two years, IR has taken significant steps towards becoming a diversified industrial concern through the divestiture of Bobcat and other construction businesses and with the acquisition of Trane."

Ingersoll Rand now operates market-leading brands in the following businesses:

- Hussmann: display cases and refrigeration systems for food retailers
- Thermo King: refrigerated transport
- Trane: HVAC
- Club Car: golf cars and utility vehicles
- Ingersoll Rand: legacy brands including compressed air system products
- Schlage: security products

Ingersoll Rand recently reported 2009 full-year revenues of $13.2 billion for the whole company. IR also recently reported fourth quarter 2009 revenues for ITS of $591 million. Due to the timing of the meeting, Mr. Bloch had to use 2008 numbers and statistics stating that IR ITS had 2008 revenues of $3 billion. Of that total, 66% came from "complete machines" and 34% from "aftermarket products". He further explained that "Geographic sales, in 2008, were 53% from North America and 34% from the European-Served-Area (ESA)."

Mr. Bolch made the interesting comment that the integration of this new company, over the past two years, had resulted in the application of many "smart technologies to industrial technology."

The 3 Drivers for IR Product Design

1. Reliability
2. Efficiency
3. Productivity

INNOVATION AT INGERSOLL RAND

"Over the past two years, IR has taken significant steps towards becoming a diversified industrial concern through the divestiture of Bobcat and other construction businesses and with the acquisition of Trane."

— Jim Bolch, President of IR's Industrial Technology Sector

Outcome Driven Innovation

During this period of transformation, "IR spent nine months surveying 2,500 customers from 13 industries located in the United States, U.K., Germany and China", explained **Manlio Valdes**, the vice president for Global Product Management at IR. "Investments in new product development were increased significantly in 2009 and now again in 2010. Our process is called 'Outcome Driven Innovation' (ODI), and it focuses on listening to the needs of our customers and responding to them." Mr. Valdes further explained that after all the market research was completed with Voice-of-the-Customer and Voice-of-the-Channel surveys, the overall drivers for new product design were identified (in no particular order) as reliability, efficiency and productivity.

Launched at this event were two main "Benchmark Platforms" for the new R-Series rotary screw and C-Series centrifugal air compressors. Mr. Valdes commented, "These new air compressor benchmark platforms integrate the drivers of reliability, efficiency and productivity."

The New R-Series Contact-Cooled Rotary Screw Compressor

When you've been around a lot of product launches, you start to adopt the Missouri attitude/slogan of "Show Me" before you get excited. I confess I felt this way at the start of the showcase. When we began to review the new R-Series contact-cooled, rotary screw compressor, however, **Ron Ratell** (Global Category Manager) and **Robert Horneman** (Global Portfolio Manager) quickly got my attention. "We are now launching the first phase of the R-Series with 125–200 horsepower (90–160 kW) models," said Mr. Ratell. "This is part of a multi-phase introduction, which will cover models ranging from 5–200 horsepower."

The Sequential Cooling System also grabbed my attention. This new cooling system lowers standard discharge temperatures (also known as approach temperatures) to 4 ºF (2.2 ºC). This is a significant improvement over the "industry-norm" of 15 ºF approach temperatures. The **Efficiency Benefit** for end users is that this will significantly reduce the energy required

Everson Campos, Ron Ratell, Vipul Mistry, Robert Horneman and Ed Redmond (left to right) present the new R-Series Rotary Screw Compressor (and the related cost) of downstream compressed air treatment equipment. "The CTD (Control Temperature Discharge) that we use to rate compressors is a real-world 115 °F at 40% RH (relative humidity)," said Robert Horneman. "This is quite different from the unrealistic CTDs used by other firms of 68 °F and 0% RH." The independently mounted, free-floating air and coolant heat exchangers can also enable the compressor to operate in ambient temperatures up to 131 °F (55 °C).

An integrated cyclonic moisture separator connected to a standard electronic no-air-loss drain removes condensate from the air stream. Integrated refrigerated dryers are standard options on compressors up to 100 hp in size. Outlet air quality is further enhanced by a standard, 316 stainless steel, outlet piping system. This air quality **Reliability Benefit** reduces the chance of pipe scaling and the introduction of solid particulates into the outlet air.

Instead of a fan, the Sequential Cooling System uses a centrifugal blower to evacuate the heat. The **Efficiency Benefit** is that the motors are significantly smaller (vs. the fan motor) and that it is a lower-noise solution. Overall sound attenuation ratings are 74 dba (air-cooled) and 71 dba (water-cooled).

Productivity Benefits of the R-Series focus on the new Progressive Adaptive Control™ (PAC) system. This is an intelligent system, monitoring key operating parameters and adapting to prevent unexpected downtime. This involves the use of sensors to prevent components from causing the air compressor to shut down due to high-temperature or differential pressure conditions. I thought this was a great example of what Mr. Bolch referred to as "bringing smart technology to industrial technology." The idea is that the air compressor will receive signals to automatically run slower, rather than shut down and affect production in the facility. True differential pressure sensors are installed on the intake filter, lubricant filter and separator. The PAC control system monitors their readings, and can adjust the operation of the air compressor to not only optimize efficiency but to ensure up time.

> "The new cooling system of the R-Series reduces approach temperatures to 4 °F (2.2 °C)."
>
> — Ron Ratell, Global Category Manager

Chad Larrabee and Randy Finck demonstrate the controller of the new Centac C-1000

INNOVATION AT INGERSOLL RAND

The New C1000 Centrifugal Compressor

- 800–1300kW (1100–1750hp)
- 2 or 3 stage designs
- Pressures from 3.5–10.3 barg (50–150 psig)
- Capacities from 127–212 m3/min (4500–7500 cfm)
- Water-cooled, water-in-tube coolers
- 50 or 60Hz
- Std. voltages: 4160–10,000V

Efficiency Benefits are further offered with the cleverly simple way so many airend and drive options are available on the same R-Series base design. Customers can specify four energy-efficient packages combining these two critical components.

1. Nirvana VSD Premium Efficiency: variable speed drive with a two-stage airend, which provides 15% more air than single-stage units.
2. Nirvana VSD Efficiency: variable speed drive with a single-stage airend.
3. Premium Efficiency: Fixed speed with a two-stage airend
4. Fixed speed with a single-stage airend

The New Centac C-Series C1000 Centrifugal Air Compressor

Did you know that Ingersoll Rand has an installed base of 22,000 Centac oil-free centrifugal air compressors!? So says **Chad Larrabee**, Global Category Manager, Configured Air Products, at Ingersoll Rand. "IR introduced the first oil-free centrifugal compressors in 1912, and launched the Centac centrifugal package in 1968," said Larrabee. "Brand studies show that customers perceive the Centac as a compressor which will last forever!" he explained. "We are continuing with features like the AGMA-rated gearing designed for a 25-year life, high-quality and efficient impellers, and a leak-free oil system design guarantee. These are just some of the **Reliability Features** which have long established the IR Centac as the market leader."

The new C1000 represents a new benchmark platform for the Centac C-Series centrifugal compressor. A significant change to the design is the new transverse-mounted, water-in-tube coolers. Unlike the prior coolers with longitudinal mounting, the new transverse-mounted coolers allow for in-place cleaning from either side. The fact that the coolers don't have to be shipped out for cleaning is a significant **Productivity Feature** for a facility. The coolers

Matt Smith, Tom Malberg, and Dipen Shah (left to right) display the Duplex Compressor, featuring a 35% smaller footprint are oversized for greater fouling resistance and provide low compressor discharge temperatures and pressure drop. Another **Productivity Feature** is the fact that the impellers can be inspected and removed in only two steps thanks to a new "vertically-split" package design.

The new XE Series Controller has an intuitive display, which reminds me of what you see in newer cars today. Randy Finck, IR's Global Category Manager for Air Treatment and Controls, said, "Each controller is web-enabled to allow users to monitor and control the compressor from remote locations. One no longer needs to have a smudged-up, clip-board hanging next to the air compressor — the C1000 will email you up-to-date maintenance logs!" No special software is required for the new controller to communicate and the connectivity is easy to Plant DCS, automation or the internet. Finally, the XE Series Controller has **Efficiency Features** like optimized turndown, simplified ambient control and advanced surge control.

A History of Innovation

I came away from the meeting with a real sense that Ingersoll Rand is just now starting an important new chapter both as a company and in compressed air systems. The marketing materials do a nice job of showing the innovation timelines, beginning in 1872 (reciprocating compressors), to 1912 (oil-free centrifugal compressors) and through 1952 (oil-free rotary screw compressors).

The company has reorganized itself internally and is now in the launch phase of new "benchmark" designs of IR's main air compressor product lines. The managers I met are excited about the "smart technology" and the "service-friendly" features of the new air compressors. Innovation is an exciting thing when you know you are providing your customers with more value. Leaving surprisingly snowy Charlotte to ever-snowy Pittsburgh, I had the feeling that Ingersoll Rand had accomplished their product design goals of delivering **Reliability, Efficiency and Productivity Benefits** to their customers. BP

For more information, please contact Rod Smith at email: rod@airbestpractices.com, www.airbestpractices.com.

The New Centac C-1000 Air Compressor

"Investments in new product development were increased significantly in 2009 and now again in 2010. Our process is called 'Outcome Driven Innovation' (ODI), and it focuses on listening to the needs of our customers and responding to them."

— Manlio Valdes, Vice President for Global Product Management at IR

THE SYSTEMS APPROACH

What Are Your Demands?

BY THE COMPRESSED AIR CHALLENGE®

A basic element in the Compressed Air Challenge® (CAC) philosophy is that compressed air system optimization should be addressed using "The Systems Approach." This method recognizes that improving and maintaining peak compressed air system performance requires addressing both the supply and the demand sides of a system, and understanding how the two interact.

"The road to energy efficiency involves more than just fixing the leaks," says Ross Orr, an experienced auditor with Scales Industrial Technologies and a certified CAC instructor. "If you don't investigate the rest of the system, then you leave a lot of money on the table," he continues. "We have seen instances where addressing an inappropriate use of compressed air cut the total system demand by more than half. A very important step in planning a new compressed air system, or in upgrading an existing system, is to look closely at how compressed air is used."

"One of the biggest issues preventing most plants from maximizing their compressed air system's efficiency is understanding it is, in fact, a system — not just compressors and some piping," explains David Booth, another certified CAC instructor and Sullair's lead auditor/trainer. "In most cases, if you ask a plant to show you their compressed air system, they take you to the compressor room, but that's just one part — the supply side. Few are able to even identify their largest or most critical end users — the demand side," says Booth. "Fewer still know these end users' actual requirements — pressure, flow and air quality. The CAC Fundamentals course does a nice job introducing these concepts by providing some basic knowledge on the components, and then building on them to get participants thinking about not just how they *produce* air, but how they actually use it. It really makes them think about the whole system."

The investigation of the demand side involves breaking the system down into end uses, parts or "constituents," and assessing the characteristics of these elements. In this way, proper planning of efficiency and other system improvement measures can be accomplished without negatively affecting the system.

> "The road to energy efficiency involves more than just fixing the leaks. If you don't investigate the rest of the system, then you leave a lot of money on the table."
>
> — Ross Orr, Auditor with Scales Industrial Technologies and certified CAC instructor

"Few plants are able to identify their largest or most critical end users of compressed air. Fewer still know the actual requirements of the end users."

— David Booth, Certified CAC Instructor and Sullair's Lead Auditor/Trainer

"Too often, facility managers just want to buy a new compressor and think that will solve all their energy efficiency woes," says Orr. "Quite often, we find even new compressors that are inefficient at part load, or a system with a control strategy that cannot efficiently react to this new lower system demand without some modifications."

"When you can step back and take a systems approach to start analyzing the compressed air system as a whole, you start to see what is reasonable and efficient for the whole plant, and not just one component or one user," explains Booth. "Often a plant will specify and spend more money on a compressor just because it is 1–2% more efficient at some rated full load condition. But, that same plant may be adding 10–20% to their annual costs due to unnecessarily elevated pressures, or be wasting 30–40% of their compressed air through leaks or by using it to drive equipment that should not be powered by compressed air in the first place."

How Much Compressed Air Is Needed?

The CAC's Best Practices Manual (BPM) discusses end use analysis in several sections, and is a very good reference tool when studying your system. The following is an excerpt from Section 1: The Demand Side — How to Analyze New and Existing Compressed Air Systems, from *Best Practices for Compressed Air Systems*. This 325- page manual is available at our **bookstore**.

1. **What Is the Use?**

   Each industry is different, and each plant within any given industry is unique. A new plant will have specific initial requirements, but these will change over time, and anticipated growth should be considered in the initial design.

   - Identify and tabulate anticipated end uses and quantify rate-of-flow compressed air requirements
   - Machinery and processes requiring compressed air should be identified by type and the manufacturer's specified air flow requirements should be noted
   - General-use plant air also should be identified and quantified

THE SYSTEMS APPROACH: WHAT ARE YOUR DEMANDS?

2. **What Is the True (or actual) Air Requirement?**
   - List each by type, using a table similar to Table 1: Basic Demand Flow Chart, and the tables appearing in the Best Practices Manual, which also show typical uses of compressed air
   - Identify alternatives to any potentially inappropriate uses (See Fact Sheet 2 at http://www.compressedairchallenge.org/library/factsheets/factsheet02.pdf)
   - Identify steady or intermittent demand
   - Check number of shifts and resulting variations
   - Use equipment manufacturer's specifications for:
     - Average flow rate requirement
     - Maximum flow rate requirement
     - Minimum pressure requirement (challenge the stated requirement)
     - Maximum pressure requirement (is there a built-in pressure regulator?)
     - Air quality requirement (e.g. oil free, degree of dryness and filtration)
   - Note the locations (groupings or scattered?)
   - Estimate potential future additions
   - Estimate total air flow and best and worst case scenarios (include provision for leaks)
   - Develop a "Demand Profile Chart"
   - Shut off air to any application not in use
   - Determine the range of pressure requirements (should some be segregated?)
   - Determine if oil-free applications should be segregated or if all applications should be oil free
   - Determine maintenance needs
   - Each End Use Should Be Compared with Alternatives and Justified.

3. **Why the Use?**

   Not all uses of compressed air are appropriate or efficient, but in some cases may still be the better alternative (refer to "Potential Inappropriate End Uses").

4. **How to Develop a Demand Profile Chart**

   Misapplication of compressed air at the end use is very common, and results in the system operating inefficiently. A demand profile chart can assist in identifying applications that lead to poor system performance, excessive energy costs and increased maintenance and repair expenses. Minimum, average and peak rates of flow, combined with on/off cycle times, are important criteria.

   The demand profile chart will provide the information for an overview of the system to determine the actual end use requirements. For a new plant, the chart is a compilation of the data required to select the total compressor capacity and the system operating pressure. The manufacturers of the end use equipment should provide this data.

   For an existing plant, an analysis of the data can assist in determining where system inefficiencies exist or where there may be opportunities for improvement. For example, an end use with small air consumption can cause the entire system to operate at elevated pressure. Determine if the application can be modified to operate at a lower pressure or if it should be segregated to allow the main system to operate at a lower pressure. For an intermittent high-volume use, additional storage may avoid the need to continually operate compressors inefficiently at partial load, merely to meet an occasional peak requirement. Table 1 shows a typical demand profile chart. End use equipment is often added or modified, so you should update the chart periodically so that it remains current.

TABLE 1: BASIC DEMAND PROFILE CHART

OPERATION	PRESSURE (PSIG)	CONTINUOUS	AVERAGE	PEAK	CYCLE TIME	
		(DEMAND IN CFM)			ON	OFF
Air Hoists	80	N/A	16.6	200	5 min	55 min
Open, Handheld Blow Guns	90	100	100	100	N/A	N/A
Vacuum Generation (venturi cups)	80	100	100	100	Production	Non-production
Automated Assembly	80	200	200	200	Non-production	Non-production
Miscellaneous Uses	70	N/A	160	200	N/A	N/A
Large Pneumatic Clamps (10 min each hr)	85	N/A	16.6	200	10 sec	10 sec
Pneumatic Actuators	80	50	50	100	Production	Production
Air Leaks	80	300	300	300	N/A	N/A
TOTAL	**—**	**750**	**943**	**1,400**	**—**	**—**

Notes:

- In some end uses, the minimum flow rate may be very low or zero (cycle time –off) until an intermittent operation (demand event) occurs, when there is a large demand (peak flow rate) for a given period of time (cycle time – on). The combination of these will determine the average rate of flow
- End uses having a steady rate of demand can be identified only with the average flow rate
- Peak flow events may require additional primary storage and/or secondary storage to maintain stable system pressures (rate of flow issues for end use applications are covered in detail in the CAC's Best Practices Manual)
- **When preparing a demand profile, pressures should also be considered, since not all end use applications require the same pressure**

TABLE 2: A TYPICAL "END USE" DEMAND LIST.

END USE	MINIMUM LOAD	AVERAGE LOAD	PEAK LOAD
	(DEMAND IN CFM)		
Baghouses/Dust Collectors	0	15	300
Packing Lines	40	60	80
Transport 1	0	48	482
Transport 2	0	67	670
Transport 3	0	90	900
Crushing	160	160	160
Miscellaneous	150	150	150
Open Drainage	50	50	50
Artificial Demand [1]	150	150	150
Leaks	850	850	850
TOTAL	**1,400**	**1,640**	**3,792**

[1] Artificial demand is defined as the excess air required by a system's unregulated uses because the system is being operated at a pressure in excess of production's true requirements. Unregulated end uses and leaks are increased by higher operating pressures. Conversely, decreasing system pressures will decrease unregulated uses and leaks, decreasing total demand.

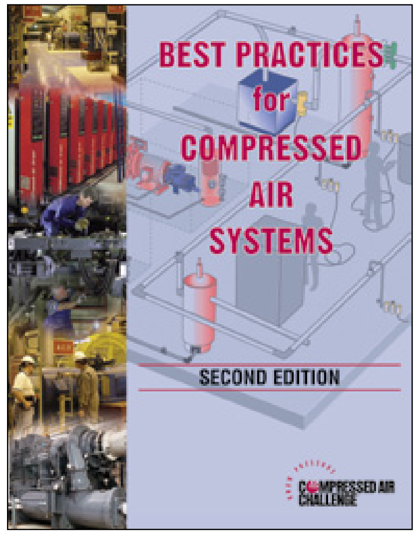
Note: there is much more information in the BPM in regards to the following items.

- **Number of shifts and resulting variations**
- **Average and maximum flow requirements**
- **When is air used (and when not).**
- **What about leaks?**
- **What is the future?**
- **What pressure is needed and why?**
- **Where is the use?**

For an existing plant, an analysis of the data can assist in determining where system inefficiencies exist or where there may be opportunities for improvement.

THE SYSTEMS APPROACH: WHAT ARE YOUR DEMANDS?

To obtain your own copy of the Best Practices Manual, please visit www.compressedairchallenge.org.



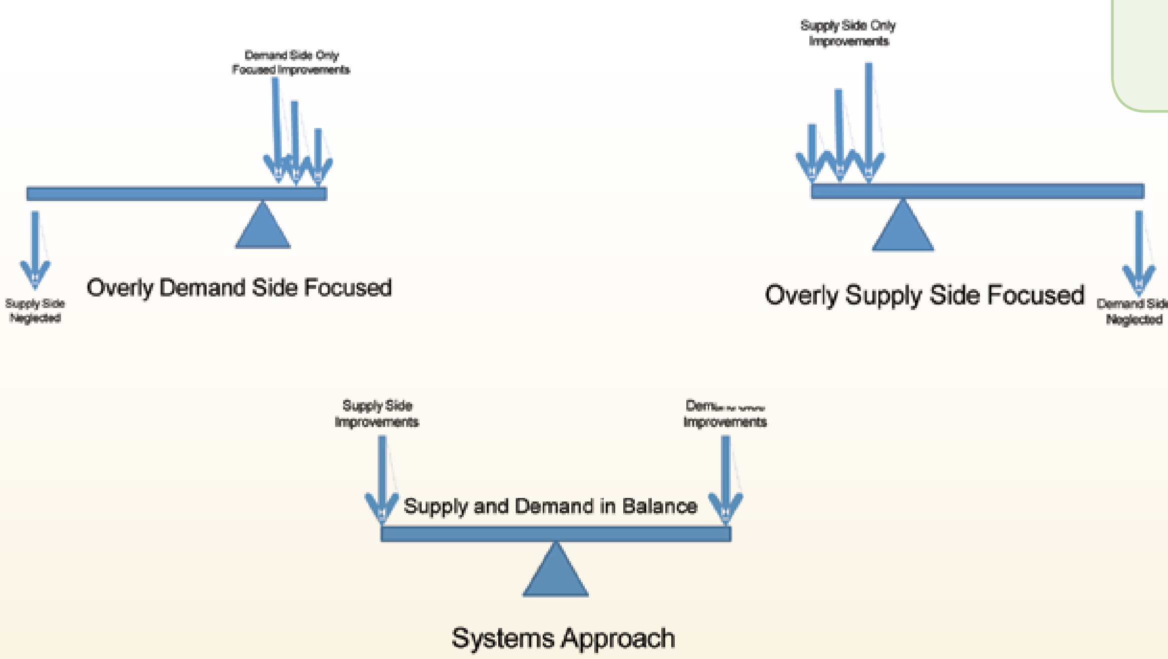
Final words from David Booth:

"When you take a systems approach, you can see that to maximize efficiency, the focus and effort must be balanced between the supply and demand sides. For peak efficiency, you must *produce* air most efficiently, but you must also *conserve* and *use* it most efficiently. In a real balance, if you move the fulcrum or focus point too far to one side or the other, it requires significantly more effort on that side to reach a balance. If you focus all your efforts on only one side (i.e. supply *or* demand), at first you may achieve reasonably good results, but it will become increasingly difficult to maintain, and will require expending more and more capital and human resources to keep improving. A much smaller effort and investment on the other side may result in huge savings." BP

For more information, please visit www.compressedairchallenge.org.

"When you take a systems approach, you can see that to maximize efficiency, the focus and effort must be balanced between the supply and demand sides."

— David Booth, Certified CAC instructor and Sullair's lead auditor/trainer



RESOURCES FOR ENERGY ENGINEERS

TRAINING CALENDAR

TITLE	SPONSOR(S)	LOCATION	DATE	INFORMATION
Compressed Air Challenge® Fundamentals of Compressed Air Systems	Hughes Machinery Co. Omaha Public Power Atlas Copco DRAW Prof. Services	Omaha, NE	3/9/10	Dennis Tribbie Tel: 402-571-5004 email: dtribbie@hughesmachinery.com www.compressedairchallenge.org
Compressed Air Challenge® Advanced Mgmt of Compressed Air Systems	Hughes Machinery Co. Omaha Public Power Atlas Copco DRAW Prof. Services	Omaha, NE	3/10–11/10	Dennis Tribbie Tel: 402-571-5004 email: dtribbie@hughesmachinery.com www.compressedairchallenge.org
Intro to Compressed Air Systems	Association of Energy Engineers Globalcon 2010	Philadelphia, PA	3/22/10	Gary Wamsley Tel: 678-977-1508 email: gary.wamsley@comcast.net

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

PRODUCT PICKS

New Cycling Refrigerated Dryer

Hankison, an SPX brand, announced the release of the new HES Series energy saving refrigerated compressed air dryer. The Hankison HES refrigerated air dryer series features ten energy savings models, ranging from 90 to 675 scfm (153–1148 nm3/h). The "Rebate-Ready" design matches load on the dryer to the energy consumed. Fully featured, HES dryers are equipped with a no air loss drain, ISO Class integral filtration and a cycling refrigeration system. A full line of aftermarket maintenance kits, CAGI third-party performance certification and a 5-year extended warranty supports the product.

Hankison — An SPX Brand
www.hankisonintl.com

New Joints for Aluminum Piping Systems

TESEO announces AP40, the latest addition to the modular system of aluminum pipes called AP. With the new 40 mm diameter (corresponds to 1.5 inches), TESEO can now offer an integrated solution from ¾" to 2" diameter, to implement compressed air distribution lines and drop columns to user stations. For the AP40 diameter, TESEO also recently introduced new L&T Joints — more ergonomic, quick to mount and cost-effective than their predecessors. The new L&T joints offer 60% quicker installation time compared to the previous version, a result of the reduction of screws (only 3) and the new design of support brackets, which enables assembly of two profiles in few minutes.

TESEO
sales@teseoair.com
www.teseoair.com

RESOURCES FOR ENERGY ENGINEERS

INDUSTRY NEWS

Hope Air Systems Presents Award to Kaeser Compressors

Kaeser Compressors, Inc. has been awarded Hope Air Systems' Zero Defect Award for the second straight year. Though Hope Air Systems has been offering compressed air equipment for over 40 years, Kaeser is the first compressor manufacturer to receive this award. It is given only to the highest-performing suppliers.

"This is the second year in a row and it is well deserved. It is our experience that once a customer buys a Kaeser, there is no other compressor he would be interested in," commented Pete Rhoten, president of Hope Air Systems.

Accepting the award, Frank Mueller, president of Kaeser Compressors, Inc., said, "We are honored to receive this important award. While we are confident in the design, quality and reliability of our units, we also know that first-class sales and service support is an integral part of true customer service. Since joining our network of representatives in 2005, Hope Air Systems has been a valuable partner in northern New England. We look forward to working with them to meet customers' compressed air needs for many years to come."

Kaeser Compressors
Tel: 800-777-7873
www.kaeser.com

Atlas Copco Acquires Distributor in Louisiana

Atlas Copco Compressors LLC has purchased the compressor division of Premier Equipment Corporation, Inc. Serving the state of Louisiana, Premier Equipment has been a successful Atlas Copco compressor distributor for many years. "The acquisition brings us closer to our customers in the region, allowing us to build on the strong base that Premier Equipment has developed in key segments," said Stephan Kuhn, business area president, Atlas Copco Compressor Technique.

The compressor division of Premier Equipment Corporation will be incorporated into the Southern Region of Atlas Copco Compressors. The non-compressor side of the business, selling mainly pumps and process equipment, will continue to operate as Premier Equipment Corporation, Inc.

Premier Equipment, based in Baton Rouge, LA, has a well-developed customer base and market presence in Louisiana. Economic activity in the region is driven largely by chemical and petrochemical refining, offshore oil services, ship building (workboats), general industry and engineering services for the oil and gas sector. Twelve employees will join Atlas Copco from Premier Equipment as a result of the acquisition.

Atlas Copco
www.atlascopco.com

LITERATURE & SERVICES PICKS

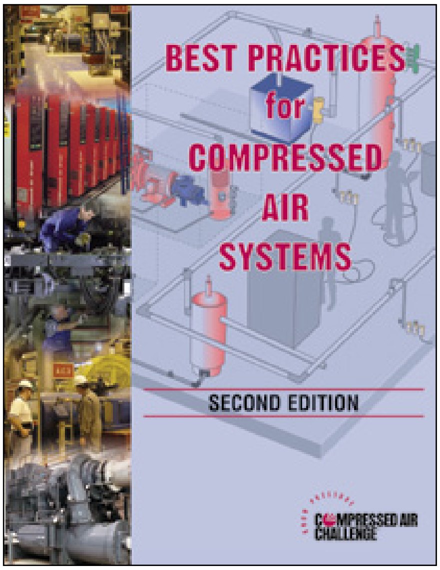
New Edition of "Best Practices for Compressed Air Systems®" from the Compressed Air Challenge®

The Compressed Air Challenge® has released the Second Edition of their authoritative "Best Practices for Compressed Air Systems®."* The Best Practices manual provides tools needed to reduce operating costs associated with compressed air and to improve the reliability of the entire system. The 325-page manual addresses the improvement opportunities from air entering the compressor inlet filter, through the compressor and to storage, treatment, distribution and end uses, both appropriate and potentially inappropriate. Numerous examples of how to efficiently control existing and new multiple compressor systems are provided in one of the many appendices.

The Best Practices manual created by the Compressed Air Challenge® begins with the considerations for analyzing existing systems or designing new ones. The reader can determine how to use measurements to audit their own system, how to calculate the cost of compressed air and even how interpret electric utility bills. Best practice recommendations for selection, installation, maintenance and operation of all the equipment are included in each section.

**The Best Practices for Compressed Air Systems® manual is a product of the Compressed Air Challenge®, co-authored by Bill Scales and David McCulloch and is not associated with Compressed Air Best Practices® Magazine.*

Compressed Air Challenge®
www.compressedairchallenge.org



The Book on Compressed Air Common Sense Answers

NEW! Providing practical solutions to the everyday issues facing plant staffs who operate and maintain plant air systems and the engineering staff who design and evaluate air systems. Real life experiences flow throughout covering common problems and opportunities that touch all industries. New electronic energy saving products are reviewed in detail, and how to apply them through the complete air system, from the compressor room to the shipping dock, is explained. Savings calculation methods and measurement protocols are identified. Features "Ask the Experts" section answering questions posed by real users to Air Power USA staff. (Red book, Hard cover. 1st edition — 2009). BP

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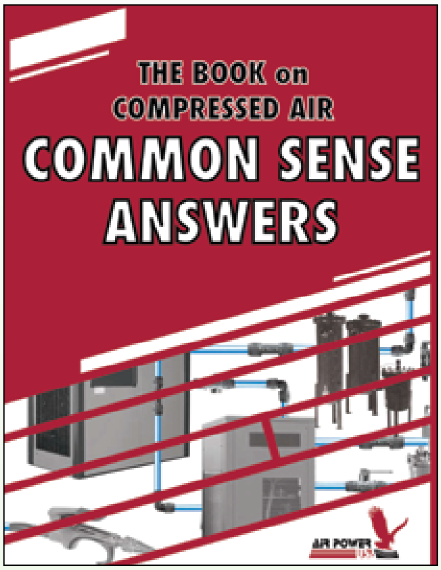
Color print copy $105.00 US
To purchase, call Air Power USA at 740-862-4112
or visit www.airpowerusainc.com



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 gathered, in this column, was during the trading day of February 25, 2010.

FEBRUARY 25, 2010 PRICE PERFORMANCE	SYMBOL	OPEN PRICE	1 MONTH	6 MONTHS	12 MONTHS	DIVIDEND (ANNUAL YIELD)
Parker-Hannifin	PH	$57.62	$56.90	$49.92	$36.28	1.70%
Ingersoll Rand	IR	$31.96	$34.88	$30.85	$15.24	1.20%
Gardner Denver	GDI	$42.34	$40.77	$32.22	$19.14	0.47%
United Technologies	UTX	$67.57	$68.00	$59.62	$42.66	2.48%
Donaldson	DCI	$40.84	$39.73	$38.63	$28.60	1.11%
SPX Corp	SPW	$58.75	$56.43	$57.59	$43.95	1.63%

Ingersoll Rand Announces 2009 Fourth-Quarter Earnings

Ingersoll-Rand plc (NYSE: IR) announced that total reported revenues decreased by 10% for the fourth quarter of 2009, compared with the 2008 fourth quarter, and adjusted earnings per share (EPS) from continuing operations were in the mid-range of prior guidance.

The company reported net earnings of $139.4 million, or EPS of $0.42, for the fourth quarter of 2009. Fourth-quarter net income included $124.7 million, or EPS of $0.37, from continuing operations, as well as $14.7 million of income, equal to EPS of $0.05, from discontinued operations. Fourth-quarter 2009 EPS from continuing operations, excluding approximately $50 million of pre-tax restructuring costs, was $0.48.

"Our revenues in the quarter came in at the middle of our guidance range," said **Michael Lamach**, president and chief executive officer. "While we continue to see challenges in some of our major end markets, we're also beginning to see improvement in markets that lead the recovery. Despite the revenue drop, we improved operating earnings and margins by continuing to drive productivity, generating synergies across our global operations and improving capacity utilization. These actions and efforts to further reduce working capital contributed to another quarter of outstanding cash generation, which allowed us to significantly exceed our 2009 targets and to accelerate the reduction of debt. We dedicated ourselves in 2009 to demonstrating that we can execute. In 2010, we will build on the productivity culture we have established by integrating our business activities and increasing our capacity utilization, both of which will improve our profitability. In addition, we are investing substantial resources to innovate and develop new products and services which will fuel our future growth."

Additional Highlights for the 2009 Fourth Quarter

Revenues: The Company's reported revenues decreased by 10% to $3,305.8 million, compared with revenues of $3,670.0 million for the 2008 fourth quarter. Reported U.S. revenues decreased by 14%, and revenues from international operations declined by approximately 5% with the sharpest year-over-year declines registered in Europe.

Operating Income and Margin: Reported operating income for the fourth quarter was $222.7 million compared with a loss of $3.5 billion for the fourth quarter of 2008. Fourth quarter 2009 included approximately $50 million of pre-tax costs related to restructuring compared with $71 million for the same period of 2008. Fourth-quarter reported operating margin was 6.7%, or 8.2% excluding restructuring, compared with a reported operating loss for the same period of 2008.

Full-Year 2009 Results

Full-year 2009 net revenues were $13,195.0 million, a slight decline compared with reported net revenues of $13,227.0 million in 2008. On a pro forma basis, including a full year of Trane results for 2008, revenues declined by 19%. Operating income for 2009 totaled $841.6 million compared with a loss in 2008, due to a fourth-quarter asset impairment charge of $3.7 billion. Operating margin for 2009 was 6.4%.

The company reported full-year 2009 EPS of $1.37. The company reported full-year 2008 EPS of $8.73.

Fourth-Quarter Business Review

Industrial Technologies: Total revenues in the fourth quarter of $591 million decreased by approximately 12% compared with the fourth quarter of 2008. Air and Productivity revenues declined by 13%, due to lower volumes in all geographic regions. Revenues in the Americas decreased by 20% compared with last year, due to declines in major industrial, process and fluid handling end markets. Americas' equipment volume declined by 23% and recurring revenue decreased by 14%. Air and Productivity Solutions revenues in Europe, Asia and India decreased by approximately 6% compared with 2008. Club Car revenues declined by 2% compared with the fourth quarter of 2008, due to ongoing sluggish golf, hospitality and recreation markets, which were partially offset by growth in low-speed vehicle sales. Fourth-quarter operating margin for Industrial Technologies of 12.4%, increased by 1.9 percentage points compared with 10.5% last year, due to higher productivity, which offset lower volumes.

Gardner Denver, Inc. Reports Fourth Quarter 2009 Financial Results

Gardner Denver, Inc. (NYSE: GDI) announced that revenues and operating income for the three months ended December 31, 2009 were $450.8 million and $54.4 million, respectively, and net income and diluted earnings per share were $37.2 million and $0.71, respectively. For the twelve-month period of 2009, revenues were $1.8 billion and the Company generated an operating loss of $113.7 million and a net loss of $165.2 million, or $3.18 on a per share basis.

"I am quite pleased with the results of the fourth quarter, which were generally in line with our expectations and attributable to the collective efforts of our employees worldwide," said **Barry L. Pennypacker**, Gardner Denver's president and chief executive officer. "Operating margin (1) for our Industrial Products Group was 8.0% for the quarter, which included a 0.5% benefit from a reduction to the impairment charge associated with finalizing the CompAir opening balance sheet. We completed a large liquid natural gas (LNG) loading arm shipment destined for South America on schedule, which contributed to an improvement in our inventory turnover to 5.4 times in the fourth quarter, 0.6 turns better than the first quarter of 2009. We were also able to reduce our days sales outstanding, which improved to 67 days in the fourth quarter of 2009 from 74 days at the end of the third quarter. These benefits, coupled with improved sequential earnings, resulted in strong cash flow from operations in the fourth quarter, which we used, among other things, to repay debt and to fund our first dividend since becoming a publicly traded company in 1994.

Fourth Quarter Results

Revenues decreased $73.5 million (14%) to $450.8 million for the three months ended December 31, 2009, compared to the same period of 2008. Industrial Products Group revenues and orders decreased 12% and 7%, respectively, for the three-month period ended December 31, 2009 compared to the same period of 2008, due to the reduced demand attributable to the global economic slowdown, partially offset by favorable changes in foreign currency exchange rates and the impact of the CompAir acquisition. Engineered Products Group revenues and orders decreased 17% and 10%, respectively, for the three months ended December 31, 2009, compared to the same period of 2008, despite a large shipment of LNG loading arms destined for South America, due to lower volume in most other product lines.

WALL STREET WATCH

Gross profit decreased $14.4 million (9%) to $144.3 million for the three months ended December 31, 2009, compared to the same period of 2008, primarily as a result of volume reductions. Gross margins increased to 32.0% in the three months ending December 31, 2009, from 30.3% in the same period of 2008, due to the benefits of operational improvements and cost reductions, despite the offset attributable to the loss of volume leverage and fixed cost absorption as production levels declined.

Selling and administrative expenses decreased $6.7 million to $84.5 million in the three-month period ended December 31, 2009, compared to the same period of 2008, primarily due to cost reductions ($17.7 million), partially offset by an increase in expenses attributable to acquisitions ($5.0 million) and changes in foreign currency exchange rates ($6.0 million). As a percentage of revenues, selling and administrative expenses increased to 18.7% for the three-month period ended December 31, 2009, compared to 17.4% for the same period of 2008, primarily due to the reduced leverage resulting from lower revenues.

Operating income and DEPS for the three months ended December 31, 2009 were $54.4 million and $0.71, respectively.

For the three-months ended December 31, 2009, as reported under GAAP, segment operating income for the Industrial Products Group was $20.7 million and segment operating margin was 8.0%, compared to an operating loss of $0.7 million in the comparable period of 2008. Adjusted operating Income for the Industrial Products Group in the fourth quarter of 2009 was $19.5 million and segment Adjusted Operating Income as a percentage of revenues was 7.5%.

Net income attributable to Gardner Denver for the three months ended December 31, 2009 increased $6.3 million (20%) to $37.2 million, compared to $30.9 million in the same period of 2008. The year-over-year increase was primarily due to lower expenses associated with profit improvement initiatives and other items, and a lower effective tax rate in the fourth quarter of 2009, as compared to the previous year.

Twelve-Month Results

Revenues in the twelve-month period of 2009 decreased $240.2 million (12%) to $1.8 billion, compared to $2.0 billion in the same period of 2008. This decrease was attributed to lower volume in most product lines and unfavorable changes in foreign currency exchange rates, partially offset by the effect of acquisitions.

Gross profit decreased $87.7 million (14%) to $550.6 million in the twelve months ended December 31, 2009, compared to 2008, as a result of the lower revenue, unfavorable mix associated with the lower volume of petroleum products and unfavorable changes in foreign currency exchange rates. Gross margin decreased to 31.0% in the twelve-month period of 2009, compared with 31.6% in 2008, due primarily to product mix and lower leverage of fixed and semi-fixed costs as production volume declined.

Compared to 2008, selling and administrative expenses increased $7.6 million in the twelve-month period of 2009 to $356.2 million, due primarily to acquisitions ($71.1 million), largely offset by cost reductions, including reductions in compensation and benefit expenses, and acquisition integration initiatives.

For the year, operating income decreased $373.4 million to an operating loss of $113.7 million in 2009, compared to operating income of $259.7 million in 2008. The operating loss in 2009 was impacted by impairment charges ($262.4 million), as well as profit improvement initiatives and other items (totaling $47.3 million). The decrease in operating income was also attributable to reduced revenue volume and unfavorable product mix, partially offset by cost reductions and acquisition integration initiatives. BP

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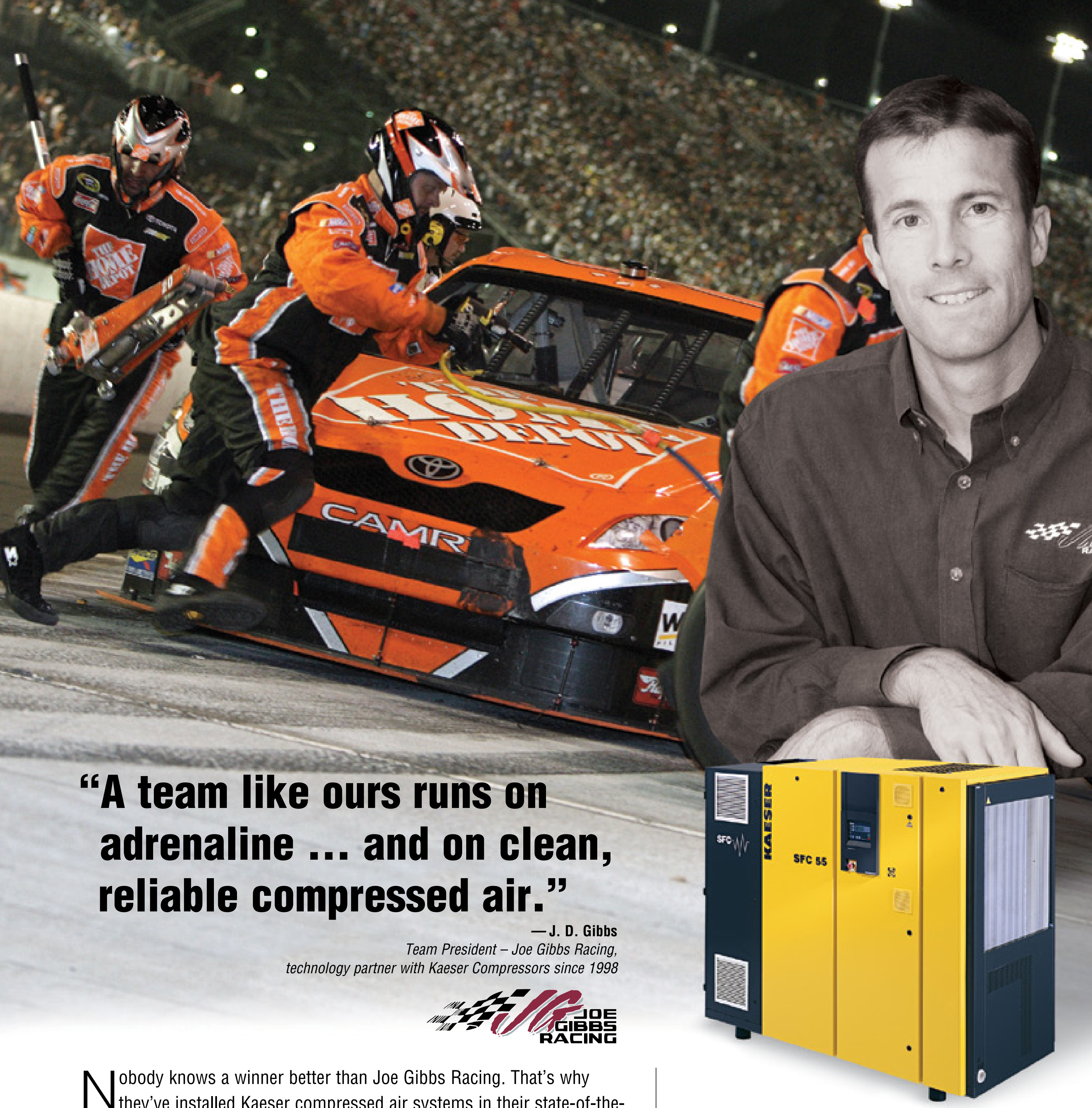
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