

# HOSPITAL AIR SYSTEM *Savings*

BY RON MARSHALL CET, CIM, FOR THE COMPRESSED AIR CHALLENGE®  
EDITED BY JAN ZUERCHER AND DAVID BOOTH

Large hospitals often use compressed air for important operational-related end uses. The systems that produce this air need to supply clean and dry compressed air with a high level of reliability. These systems are not immune to efficiency problems as is the case for any compressed air system. “For these critical types of systems, it is very important to reliably maintain a certain minimum air pressure. However, there is typically not enough data available to help accurately size the compressors,” says Brent Ehrlich, an independent air systems consultant with Air Services and a Compressed Air Challenge® (CAC) Fundamentals instructor. “Usually, without good data,” he continues, “the only way to be certain that the demand can be consistently met and pressure reliably supported, is to oversize the equipment, often leading to inefficiency.”

“Having worked in hospital maintenance and as a licensed stationary engineer, I know the importance of reliability and air quality. But as we stress in the CAC® training, it does not have to be at the expense of energy efficiency,” says Joe Ghislain, manager, Lean Supplier Optimization, with the Powertrain division of Ford and a CAC® advanced instructor. “This can be accomplished through a number of ways,” he says, “including proper selection and sizing of compressors and/or after-treatment of the air, including point-of-use filtering.” The following case study gives an example of right-sizing and optimizing a hospital air system, and follows some of the principles taught in the CAC® Fundamentals of Compressed Air seminar.



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Health Sciences Centre — Central Energy Plant



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with the Powertrain Division of Ford and a CAC® Advanced Instructor

### Health Sciences Centre Case Study

The compressed air system at the Health Sciences Centre (HSC) in Winnipeg Manitoba is critical to the operation of the complex of buildings that make up the largest hospital in Manitoba, Canada. Shortly after arriving and taking his new position as chief operating engineer, Gerry Hebert turned his attention to the compressed air system. He had inherited a lubricant-free system that incorporated a water-cooled 200 horsepower centrifugal compressor and some old reciprocating compressors. This system was used to produce the compressed air required for building HVAC controls, laundry equipment, general labs and maintenance shops at the hospital.

The centrifugal compressor had been purchased by the previous chief operating engineer to renew the aging system — formerly supplied by large reciprocating compressors. This compressor was purchased before lubricant-free screw compressors were deemed economical, or commonly available, and when the availability of large reciprocating compressors was fading.

After attending a utility-sponsored compressed air efficiency course and having some knowledge of the characteristics of centrifugal compressors, Gerry started taking note

of the variable load profile tracked by the compressed air flow meter at his site. He decided to investigate the annual operating cost of his compressor and the appropriateness of the compressor type. He also wanted to determine the system efficiency. Unfortunately, there were no energy meters tracking the power consumption of his compressors, so Gerry turned to his local power utility, Manitoba Hydro, for assistance in creating a baseline energy figure.

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# HOSPITAL AIR SYSTEM SAVINGS

## Fundamentals of Compressed Air Systems WE



The Compressed Air Challenge® (CAC) is pleased to announce the third session of *Fundamentals of Compressed Air Systems WE* (web-edition) on September 13, 2010. Led by Frank Moskowitz and Tom Taranto, this web-based version of the popular Fundamentals of Compressed Air Systems training uses an interactive format that enables the instructor to diagram examples, give pop quizzes and answer students' questions in real time. Participation is limited to 25 students. Please visit [www.compressedairchallenge.org](http://www.compressedairchallenge.org) to access online registration and for more information about the training.

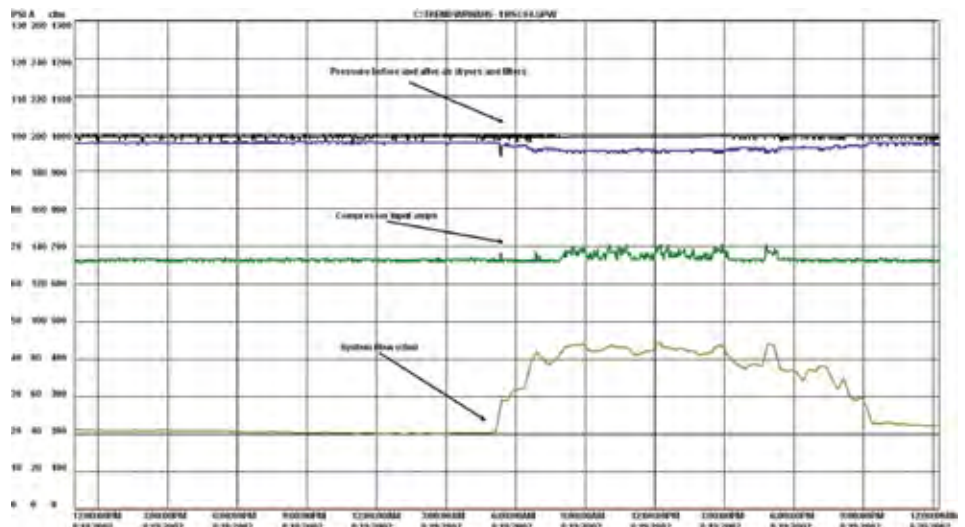
If you have additional questions about the new web-based training or other CAC® training opportunities, please contact the CAC® at [info@compressedairchallenge.org](mailto:info@compressedairchallenge.org) or call 301-751-0115.

An energy audit of the centrifugal compressor showed that while the compressed air demand of the hospital was variable, the power consumption of the compressor was very flat. Calculations showed that the average load was slightly under 300 cfm, yet the energy consumption of the system was topping 1,400,000 kWh — costing \$68,500 per year in operating costs. The specific power of the compressor alone was averaging a staggering 49 kW per 100 cfm (more than double what would be expected). The compressor also used chilled water that required additional refrigeration energy to produce, and the system had non-cycling style refrigerated air dryers installed, increasing the system specific power number to 57 kW/100 cfm.

With the assistance of Manitoba Hydro's Performance Optimization Program technical support and financial incentives, the HSC was able to purchase an air-cooled variable speed drive lubricant-free compressor and cycling-style refrigerated air dryers that were better able to track the varying loads of the facility. The more efficient system operation and the removal of the chilled water costs reduced the system-specific power to a more reasonable 18 kW per 100 cfm — saving \$39,500 in annual operating costs, or more than half the original costs.

After the initial project was completed, HSC staff noted the close proximity of the boiler intake air to the hot air discharged from the compressor coolers, and decided to put the heat of compression to good use. Using the heated compressor, cooling air is a very effective way of tempering the cold combustion air in winter, and adds additional heat to the boiler combustion in summer, increasing boiler efficiency. Previously, the intake air was pre-conditioned with steam heat on colder days. This heat recovery displaces an estimated 37,500 cubic meters of natural gas, worth about \$12,000 per year.

In all, the changes to the HSC compressed air system and the heat recovery saved a total of \$51,500 in operating costs. These savings are almost as large as total annual cost to operate the original inefficient system!



Graph 1 – The original compressor consumes almost-constant power due to its poor turndown or part load characteristics. See the middle line on the graph above.



“A large majority of the input energy used in compressing air is converted to heat, capturing and reclaiming this waste heat yields a great opportunity to improve efficiency and reduce energy cost. Whether you are utilizing it for space heating, air drying or, as in this case, boiler air makeup, heat recovery can be very cost effective and save you money.”

— Joe Ghislain

**Learn about Selecting Compressor Types**

Participants in the Compressed Air Challenge® **Fundamentals of Compressed Air** training learn the differences in the characteristics of various types of compressors. After completing the course, participants will be able to understand why the original compressor in the HSC case study showed very low efficiency and the reason why the turndown capability of the new lubricant-free screw VSD compressor improved the situation. They will learn that centrifugal compressors are an excellent choice for systems with flat constant loading near the top of their capacity curves, but are less appropriate if oversized or used alone on a varying profile, like HSC's. “Centrifugals are a great choice for lubricant-free air, but only if the demand is large enough to warrant it,” explains Ghislain. “Typically, these machines can only turn down 20–30%, so any time the base load or even low load goes below this point, the centrifugal will blow off, acting like a large air leak. The longer it stays in this condition, the more energy and dollars wasted.”

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# HOSPITAL AIR SYSTEM SAVINGS

## CAC Qualified Instructor Profile

### Joe Ghislain

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Joe is currently the Manager, Lean Supplier Optimization, with the Powertrain division at Ford, and has over 30 years' experience with Energy, Compressed Air Systems and Powerhouse operations, starting as a Stationary Engineer in a hospital, then with Ford Motor Company as a Power House Chief Engineer, Corporate Energy Engineer, Manager of Energy Efficiency, and Manufacturing Planning Manager. He received his B.S.E.E.T. from DeVry Institute of Technology and his M.A. in Business Management and Energy from DePaul University. He is a Registered Environmental Manager from NREP and both a Certified Energy Manager and Certified Sustainable Development Professional from AEE. Joe has served on the Compressed Air Challenge® Project Development Committee since its inception, and is an instructor for both Fundamentals and Advanced Compressed Air System Training.

The following is an excerpt about centrifugal compressors taken from the CAC® “Best Practices for Compressed Air Systems.” This 325-page manual is available at our bookstore and the handout material is distributed at our CAC® **Fundamentals of Compressed Air** course.

## Centrifugal Compressors

Centrifugal compressors have a characteristic curve of rising pressure as capacity decreases. A limit is reached where surge can take place, a phenomenon where a flow reversal occurs. The most common method of capacity control is to maintain a constant discharge pressure by progressively closing an inlet valve as demand is reduced and pressure tends to rise. This reduces the mass flow through the compressor and also increases the overall pressure ratio. Capacity can normally be reduced from 100% capacity to about 70–80% capacity, with reasonable reduction in energy consumption. A refinement of this method of capacity control is to replace the inlet valve with inlet guide vanes. While restricting the flow of inlet air, the guide vanes also make the air flow in the direction of rotation of the impeller inlet, providing more efficient part-load operation. In both cases, the reduction in capacity is limited to prevent the possibility of surge.

The compressor may continue to compress at the aforementioned 70–80% minimum allowable capacity. Any excess air is discharged through a blow-off valve, usually to the atmosphere, with no further savings in energy. This mode of operation should be avoided to conserve energy. Alternatively, at the minimum allowable capacity, some compressors may be unloaded, no longer discharging to the system. With the inlet valve closed, these compressors can operate in a load/unload control mode similar to a non-lubricated rotary screw compressor. This is very efficient compared to the use of a blow-off valve, but will require adequate storage capacity to avoid short cycling.

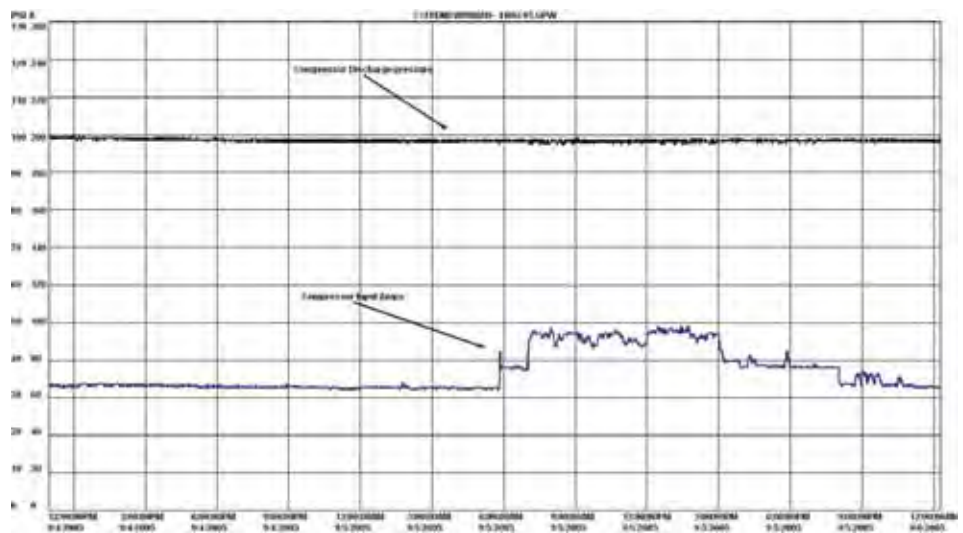


Chart 2 – The new compressor consumes less energy, which now tracks the facility flow profile (flow omitted).

Constant pressure control may be attained by means of an inlet throttling valve or by more efficient inlet guide vanes. The amount of reduction in capacity is limited by the surge line, where a reversal of flow can occur, and should be avoided. The compressor can then be arranged to discharge excess capacity to atmosphere (which is very wasteful), or to unload.

### Compressor Selection

Selection of air compressors and controls must take into account the requirements of the different points of use, the air capacity for each when fully loaded and the frequency of these requirements. Demands often are intermittent, but the “worst case scenario” also must be considered. Standby compressor capacity must also be considered, taking into account the essential nature of an application and the cost of downtime compared with the cost of a spare compressor.

The capacity and load swings will be a major factor in determining the type of compressor chosen. A general rule is that compressors with the best full-load efficiency should be used for continuous base-load type of service. Compressors with good part load efficiency are better suited to swings in load. This means that a compressor(s) with good full load efficiency may be sized for the minimum or average demand, while a compressor(s) with good part load efficiency can be sized to handle the swings in load from minimum or average to the peaks. **BP**

### CAC Qualified Instructor Profile

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Brent has been a CAC® instructor since 1999, and is AIRMaster+ certified. He operates a consulting business, Air Services, serving clients nationwide. He has performed system audits and assessments for the US DOE, The Tennessee Valley Authority, Duke Energy, Virginia Power, Enron and directly for numerous industrial facilities.





The instructors featured here are available to lead a Compressed Air Challenge® seminar at your facility. Visit [www.compressedairchallenge.org](http://www.compressedairchallenge.org) for more information.



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## LITERATURE & SERVICES PICKS

### The Compressed Air System Solution Series®



Scot Foss has provided his expertise to many of the world's leading manufacturing and processing corporations by finding solutions to their problems. Foss is one of the world's leading experts in compressed air systems, known for his sometimes-controversial approach to the issues that face plant engineers, maintenance managers and production engineers.

Written in a conversational format, this 1,100-page book with 165 illustrations brings you solutions with a straight on, common sense approach supported by technology. The author focuses on concepts and applications, which are guaranteed to improve production results and energy efficiency. The chapters of the book are as follows:

- |  |                                     |
|--|-------------------------------------|
| 1. Change Your Way of Thinking about Compressed Air  | 6. Piping and Piping Systems        |
| 2. Designing a New System                            | 7. Compressor and System's Controls |
| 3. Troubleshooting the System                        | 8. The Business of Demand           |
| 4. Instrumentation and Information Management        | 9. Supply Energy                    |
| 5. Compressed Air Storage and Using Potential Energy | 10. Cleaning Up Compressed Air      |
|  | 11. Standards and Specification     |

The cost of the book is \$195.99. To order the book, make a check or PO out to: Air's a Gas, Inc., 3728 Berenstain Drive, St. Augustine, FL 32092, or call 904-940-6940, fax 904-940-6941 or e-mail: [airsagas@aol.com](mailto:airsagas@aol.com). A portion of the proceeds from this book will be donated to selected children's charities.

### 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. **BP**

*“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](http://www.compressedairchallenge.org)