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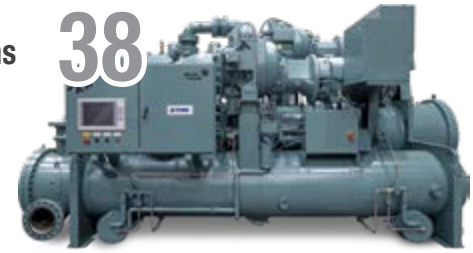

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FROM THE EDITOR

Compressed Air and Cooling Efficiency for Heavy Industry

Our annual heavy industry issue includes case studies from a West Texas silica mine, a circuit breaker factory in Nebraska and an aerospace manufacturer in Texas. We go in-depth on heat recovery, oil-free compressed air and energy-efficient free cooling.

We're delighted Anand Varhala, Director, Energy & Sustainability, Schneider Electric, shares how his company implemented a heat recovery project at its Lincoln, NE, circuit breaker factory, saving 6,000 MMBtu ($55,000) and 4.5 million gallons of water ($45,000) in its first heating season, while reducing Scope 1 CO_2 emissions by 360 tons.

We continue our executive interview series with a one-on-one conversation between Everson De Campos, CEO, FS-Elliott, and our Publisher, Roderick Smith. They discuss factory investments, new service demands from industrial customers, new product development and sales channel training.

Brandon & Clark is a compressed air system engineering and service company serving industry in West Texas. John Curtis, Compressor Department Manager, explains how his team prevented frequent failures in the compressed air system of a silica mine, a harsh and abrasive environment. Increasing preventative maintenance was the solution.

Rob Tanner, Director of Marketing, Applied Equipment, Johnson Controls, discusses the unique demands of process cooling for heavy industry, where process temperatures can exceed 1,000°F (538°C), and some equipment – such as steel blast furnaces and cement kilns – can run well above 2,000°F (1,093°C).

Free cooling is an efficient way to provide cooling without running chillers, but cooling operators need to understand its two biggest challenges: managing the transitions to free cooling mode and then back again to chiller use. Clayton Penhallegon, Jr., P.E., Managing Member, Integrated Services Group, provides detailed assistance.

A major aerospace manufacturer in Texas reduced the material cost for a new aluminum compressed air piping system by over 40% and reduced installation time by 25% when it switched from a 4-inch main line to a 2½-inch main line in a loop configuration. Ryan Freymuller, Sales Director, Manufacturers Distributor, Inc., explains the evaluations that ensured strong performance.

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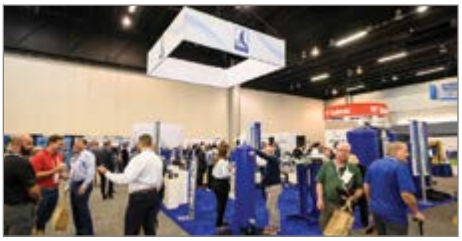
"I'm looking to establish a strong network of some of the world's best compressed air experts, because we need some assistance writing best practices and refinery engineering practices. It all starts with first getting the right network of people." ***– Raymond Hooks, Utilities and Chemical Treatment Engineer, Phillips 66***

"This was one of the best sales engineering workshops I've been to in the last several years. This was totally relevant information for industry." ***– Nathan Toro, Sales Consultant, Mobile Mechanical Services***



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Subscribers From Around the World

We salute all Best Practices Magazine subscribers from around the world who own, operate, maintain, engineer and provide expertise for the on-site utilities (compressed air, nitrogen generation, vacuum, blowers, chillers, cooling towers and pumps) powering modern plant automation. This subscriber-driven monthly column hopes to build community and recognize all subscribers!

During a sales trip to Florida, our Publisher had the pleasure of visiting Ring Power's Air Compressor Group training center in St. Augustine, FL. Ring Power is a Sullair distributor with parts and service locations throughout the state. Pictured here are Roger Adkins, Hunter Hendrix, Michelle Jordan, Scott Sweet and Greg Sagosz (left to right). Look for a profile of Adkins, Vice President, Air Compressor Group Business Manager, in our July issue. Visit https://www.ringpower.com.

We compliment Randy Beachchamp and Steve Eckard, Tate Engineering (left to right), on their choice of lunchtime reading material. Based in Baltimore, MD, this family-owned company has been providing industrial mechanical services to the Mid-Atlantic region for over 100 years. Visit https://tate.com

Based in Houston, TX, Dynamic Rental Solutions provides a variety of industries – including food and beverage, manufacturing, petrochemical and pharmaceuticals – with rental air compressors, industrial blowers and fans when needed. It stocks reciprocating, rotary and centrifugal air compressors. Pictured here are Shawn Overstreet, Thomas Cook, Kevin Burnett, Jayden Lumpkins, Roger Greer, Nick Tuma and Mark Shedd (left to right). Visit https://dynamicrental.com.

Submission Guidelines

We invite our subscribers to send in pictures so we can see the people who read our Best Practices magazines! Those holding a recent magazine issue will receive first consideration. Please send a high-resolution picture as a JPG with a note describing the team and company to Troy Dreier at troy@airbestpractices.com.

ABB is a global leader in electrification and automation. Building on more than 140 years of industrial innovation, the company now counts over 105,000 employees around the world. The company is based in Zurich, Switzerland, with U.S. headquarters in Cary, NC. Product lines include motors, drives and control systems. We caught up with Luke Buschman, National Business Development Manager, ABB Drives, at a recent expo. Visit https://www.abb.com.

Generon manufactures and/or packages membrane and pressure swing adsorption nitrogen generators, oxygen generators, air compressors and industrial blowers, focusing on the oil and gas, petrochemical, marine and industrial markets. Its engineers regularly custom-engineer products to users' specifications. It's based in Houston, TX. Pictured here are Marie Follin, Marketing Manager, and Tom Jeffers, CEO (left to right). Visit https://www.generon.com.

NEWS Compressed Air Industry & Technology

Freedom Compressor Acquires Wright Air, Expanding Service Capabilities in the Houston Market

Freedom Compressor, a growing force in the air compressor service and repair industry, has acquired Wright Air, a respected distributor of Sullivan-Palatek for more than 30 years.

Freedom Compressor moved into Wright Air's former facility, and is committed to carrying forward the company's legacy of high quality diagnostics, repairs and customer service for Houston and the surrounding communities.

The acquisition also expands Freedom Compressor's portfolio of trusted partners, adding Sullivan Palatek to an already strong lineup including Tamsan-USA, Hertz Kompressoren, BEKO TECHNOLOGIES, Dryline Technologies and Prevost USA.

"As a veteran-owned business, we operate with the same values instilled during my service in the United States Air Force: integrity first, service before self and excellence in all we do," said Sam Curiel, President, Freedom Compressor, and U.S. Air Force veteran. "Our goal is not to make a sale and disappear. Our goal is to provide every customer with a real diagnosis and real solutions for their air compressor system."

The Freedom Compressor team brings decades of collective experience in the air compressor industry and continues to expand its workforce to better serve the community. The company offers a full suite of air compressor services, including new air compressor sales, expert repairs performed by a skilled team dedicated to quality workmanship, professional air piping installation and a range of rental units sized to meet diverse operational needs.

Driven by a commitment to reliability and honest diagnostics, Freedom Compressor pairs hands-on expertise with advanced technology. Modern diagnostic tools, data-driven analysis and predictive maintenance capabilities allow the team to identify issues with greater precision and help customers avoid costly downtime. For more information, visit https://fc-hou.com.

Freedom Compressor team members

FS-Curtis Recognizes Arizona Air Compressor, Industrial Air, LBS Corporation and Pina Brothers

FS-Curtis welcomed its Platinum Channel Partners and members of the FS-Compression sales team to St. Louis, MO, for a dynamic sales meeting centered on innovation, collaboration and shared success.

The multi-day event brought together distributor leaders from across the country for strategic discussions, key business updates, new product conversations and targeted training sessions designed to strengthen alignment and support continued growth throughout the FS-Curtis network.

Robert Lee, President, FS-Curtis; Craig Mazzatenta, President, LBS Corporation; Ryan Jarvis, National Sales Director, and Russel Warner, Vice President of Sales, FS-Curtis (left to right).

"Our Platinum partners are instrumental in delivering the performance and reliability customers expect from FS-Curtis," said Ryan Jarvis, National Sales Director, FS-Curtis. "This meeting allowed us to exchange ideas, showcase new advancements and ensure we are collectively positioned for a strong year ahead."

A highlight of the meeting was the presentation of the 2025 FS-Curtis Distributor Awards, recognizing outstanding achievements across the partner network.

- Top Total Sales: Arizona Air Compressor
- Highest Aftermarket Connectivity: Industrial Air
- Total Solutions Sales: LBS Corporation
- Spirit of FS-Curtis: LBS Corporation
- Biggest Year-Over-Year Growth: Pina Brothers

These awards reflect the exceptional dedication, performance and customer commitment demonstrated throughout the year.

The event reinforced FS-Curtis's ongoing commitment to investing in its partners through training, innovation and collaboration, ensuring customers continue to receive best-in-class compressed air solutions backed by a trusted distribution network. FS-Curtis looks forward to building on the momentum from this year's meeting and continuing to drive success together in 2026 and beyond. For more information, visit https://us.fscurtis.com.

BEKO TECHNOLOGIES Ireland Launches

BEKO TECHNOLOGIES announced the launch of an Ireland operation and appointed Mark Hayes as Country Manager. The company sees huge potential in this market and recognizes the need to have an Irish-run operation to grow the business in Ireland. This operation will also simplify logistics and financial matters with BEKO TECHNOLOGIES' headquarters in Germany.

"We see great, untapped potential in the Irish compressed air market," said Martin Potter, Managing Director, BEKO TECHNOLOGIES. "Pharmaceuticals and the food and beverage industry are already big in Ireland, and there's a huge emerging market for compressed air in data centers. As a business driven by family values, BEKO TECHNOLOGIES decided to invest in local people and resources in Ireland, and finding Mark Hayes was a huge step forward."

Mark Hayes, a County Tipperary native, has 26 years of experience in engineering and industrial solutions, energy efficiency and relationship management. He started his career in the structural and architectural steel industry, where he worked for 13 years in the areas of manufacturing, design and energy for a market leader in Ireland. Having moved to a global manufacturer of construction, mining and compressed air equipment, Hayes spent nine years in that company's compressed air business, first in service, then in after-market sales.

Mark Hayes, Country Manager, BEKO TECHNOLOGIES Ireland

From his earlier work, Hayes knew BEKO TECHNOLOGIES as a global market leader in the compressed air business. "But they weren't a market leader in Ireland," he said. "My mission is to make BEKO TECHNOLOGIES the number one in Ireland. With our increasingly energy-efficient compressed air treatment range, I'm committed to helping customers optimize their compressed air systems and assist them in achieving cleaner air, lower running costs and a significantly reduced carbon footprint." For more information, visit https://www.beko-technologies.com.

Shaw Moisture Meters Introduces AcuDew Modbus RTU Dewpoint Transmitter

Shaw Moisture Meters launched the AcuDew Modbus RTU Dewpoint Transmitter, a high-performance instrument engineered specifically to help compressed air users measure and monitor moisture more effectively across their plants.

Designed for compressed air dryers, distribution networks and point-of-use monitoring, the AcuDew Modbus RTU delivers accurate, real-time dewpoint data directly to PLC and SCADA systems over an RS-485 Modbus RTU network. By giving operators clear visibility of air quality at critical points, the transmitter supports improved reliability, product quality and energy efficiency in compressed air systems.

Shaw Moisture Meters' AcuDew Modbus RTU Dewpoint Transmitter

The AcuDew Modbus RTU combines a high-performance dewpoint sensor with a compact stainless-steel housing suitable for demanding air compressor rooms and industrial environments. Shaw Moisture Meters designed the dewpoint transmitter for installation in compressed air lines and dryer outlets, providing fast response and stable measurements across a wide dewpoint range. In addition to Modbus RTU, the transmitter offers a 4-20 mA output, enabling use with either modern networked systems or traditional control loops.

"The AcuDew Modbus RTU gives compressed air users the visibility they need to run dryers and distribution systems at peak efficiency," said Loizos Konstantinou, Sales, Shaw Moisture Meters USA. "With robust dewpoint measurement and native Modbus RTU communication, customers can easily integrate moisture monitoring into their existing control infrastructure and make data-driven decisions about air treatment and maintenance."

The AcuDew Modbus RTU Dewpoint Transmitter is now available for OEMs, compressed air system integrators and end users throughout North America. For more information, visit https://www.shawmeters.com/usa.

NEWS Compressed Air Industry & Technology

Tamturbo Announces Changes in Management

Tamturbo announced Igor Nagaev, its current CEO, is moving to new responsibilities as the Head of the Central and Southern Europe and Middle East business area. Nagaev's extensive industry experience and strong expertise with global key accounts will support the company in achieving its growth targets in these market regions.

The company appointed Janne Leinonen as the new CEO, and he will assume his duties by Aug. 3, 2026. Leinonen has significant previous experience in business leadership roles from ABB, and he joins Tamturbo from his role as CEO of Trussmatic. Under Leinonen's leadership, the company will continue to focus on international growth and strengthen its position as a provider of technologically advanced compressed air systems.

"A key objective of the company's strategy is to strengthen its global presence by investing in different geographical business areas, and I'm excited to support the achievement of that objective in my new role," Nagaev said.

Leinonen said, "Tamturbo is a unique company whose Finnish technology and expertise offer a significant opportunity to create value for customers worldwide. It is a privilege to lead the company into its next phase of growth. I strongly believe that together with our employees and partner network, we can further accelerate Tamturbo's international development."

During the transition period, until Leinonen assumes his duties, Antti Kaura, the company's Chief Operating Officer, will serve as acting CEO. For more information, visit https://tamturbo.com.

ENMET Introduces the GSM-60 Advanced Monitoring System

ENMET launched the GSM-60, its most advanced real-time ambient air monitoring system, built for both hazardous and non-hazardous environments. Featuring an internal 0.5 LPM sampling pump and the ability to use internal sensors or remote transmitters, it can continuously monitor up to four gases simultaneously. Its flexibility makes the GSM-60 ideal for applications ranging from MRI oxygen monitoring to tank headspaces, HVAC ducts, VOC scrubber exhaust and wastewater treatment facilities.

Supporting infrared, electrochemical, PID, MOS and catalytic sensor technologies, the GSM-60 detects a wide range of gases, including VOCs, carbon monoxide, carbon dioxide, oxygen, trace hydrocarbons and highly reactive gases such as arsine, chlorine dioxide, ethylene oxide, hydrogen fluoride and ozone. This versatility makes it a strong solution for medical, pharmaceutical, aerospace, waste treatment and industrial environments.

The system features an intuitive push-button interface with a backlit LCD, password-protected settings, field-adjustable alarms, programmable relays and on-site calibration. Audible and visual alarms, LED indicators, dual alarm thresholds and a four-minute audio defeat option provide clear, controlled response in demanding settings.

Every GSM-60 is custom-configured to a company's monitoring needs. Provide required gases, ranges and alarm points, and ENMET will build a customized solution. For more information, visit https://enmet.com.

ENMET's GSM-60

Hitachi Global Air Power Donates Portable Air Compressor to Benefit ARA Foundation and Humane World for Animals

Hitachi Global Air Power US announced its donation of a custom-designed Sullair 185 Tier 4 Final portable air compressor to the American Rental Association (ARA) Foundation Charity Auction. Additionally, the company will make a separate $10,000 charitable donation to Humane World for Animals in support of animal protection.

"It's become a tradition to donate a one-of-a-kind air compressor to the ARA Foundation and to tie it to an impactful cause that's meaningful to our colleagues," said Todd Rozar, Vice President of Portable Sales, Hitachi Global Air Power. "This year in particular marks a significant milestone, as we celebrate 50 years as an associate member of the ARA. This coincides with the ARA Foundation's own 50th anniversary, and we are proud to continue our long-standing support of the equipment rental industry."

To date, Hitachi Global Air Power's contributions have raised over $155,000 for the ARA Foundation Charity Auction and an additional $50,000 for outside charities that inspired the designs of the donated air compressors.

Donated Sullair 185 portable air compressor

The custom Humane World for Animals-themed Sullair 185 portable air compressor is powered by a 49 horsepower (hp) Kubota 1803 diesel engine delivering 185 cfm of air at 100 psi (7 bar). Designed for reliability and performance, this model is a top choice for rental companies and is widely used in construction, mining and landscaping. For more information, visit https://www.hitachiglobalairpower.com.

Donaldson Elects Chief Operating Officer Richard Lewis to Succeed Tod Carpenter as President and CEO

Donaldson Company appointed Chief Operating Officer Richard Lewis as President and Chief Executive Officer. Lewis succeeds Tod Carpenter, who will transition to Executive Chairman after a career spanning 30 years at Donaldson. Lewis will also join the company's board.

"On behalf of the board, we extend our sincere appreciation to Tod for his exceptional leadership and decades of service," said Christopher Hilger, Lead Independent Director. "Under Tod's leadership, Donaldson significantly expanded revenue and profit, strengthened its operating model and created long-term shareholder value by fostering a strong, principled culture. With Rich's deep understanding of Donaldson's businesses and operations, the board is confident the company will continue to execute well and build on its long track record of success."

Richard Lewis will succeed Tod Carpenter as President and CEO of Donaldson.

Lewis joined Donaldson in 2002 and became Chief Operating Officer in August 2025. He has held a broad range of senior leadership roles across the company, including overseeing global operations as Senior Vice President and serving as President of the Mobile Solutions and Life Sciences businesses. For more information, visit https://www.donaldson.com.

NEWS Chiller & Cooling Industry & Technology

Johnson Controls Launches Smart Ready Chillers for Day-One Connectivity and 32% Fewer Unplanned Service Calls

Johnson Controls launched the next generation of Smart Ready YORK Chillers with factory-installed connectivity to harness real-time performance insights from day one.

On average, the company's customers using connected chillers experience faster identification of any potential issues remotely, 32% fewer unplanned service calls, improved reliability and lower total cost of ownership.

Smart Ready Chillers empower operators to access critical data to set parameters at startup, validate performance baselines and monitor system health using advanced fault detection and diagnostics. This connected solution streamlines commissioning while advanced algorithms immediately begin to learn the chiller to detect even the slightest change in performance, then flag any potential issues as soon as possible to maximize uptime and operating efficiency.

Centrifugal chillers will lead the rollout of this technology with rotary screw and scroll models to follow.

Johnson Controls' Smart Ready YORK Chiller control panel

Johnson Controls Smart Ready Chillers enable digital service capabilities to meet diverse customer needs. Its standard digitally enabled services include the ability to remotely gain insights coupled with on-site support, ideal for all types of customers looking to achieve more reliability, better performance and fewer operational risks.

With over 200 datapoints available immediately, Smart Ready Chillers deliver advanced analytics enabled with AI to help operators catch issues early and optimize ongoing performance.

"Chillers are one of the most critical pieces of equipment in a building, and even small performance deviations can jeopardize uptime and drive up lifecycle costs," said Tyler Smith, Vice President, Global Lifecycle Solutions, Johnson Controls. "Smart Ready Chillers give operators the real-time data they need to maintain peak efficiency, increase uptime, reduce operating costs and extend the life of their investment, while keeping occupants comfortable." For more information, visit https://www.johnsoncontrols.com.

Danfoss Unveils Next Generation iC7-HVACR Drive Portfolio

Danfoss introduced the iC7-HVACR – a new product portfolio bringing together variable speed drives, ultra-low harmonic drives and bypasses. The iC7-HVACR combines intelligence, efficiency, ease of use and reliability to deliver unmatched performance for today's indoor climate and infrastructure demands.

All iC7-HVACR drives come with built-in intelligence, enabling the drive to become the controller with integrated sensors, new add-on sensor types, HVACR-specific functions and powerful analytics to streamline and reduce complexity in building management systems (BMS).

The iC7-HVACR ultra-low harmonic variant with an integrated active rectifier delivers exceptional THDi (<3%) and minimal losses – ideal for IEEE 519 applications requiring superior power quality. Advanced 3-Level silicon carbide (SiC) IGBT technology allows for a compact, lightweight and easily integrated drive package.

Completing the iC7-HVACR portfolio is the iC7-HVACR Bypass, offering advanced intelligence, strong performance and unmatched reliability and uptime through its integrated iC7-HVACR platform control. With built-in sensors and software, users gain features such as power measurement, electronic overload functionality and both status and control through the BMS to ensure operational continuity regardless of operating mode.

"The iC7-HVACR Bypass is designed to help our customers work smarter and faster – whether you're installing, commissioning or operating the system long term," said Joe Horn, iC7-HVACR Bypass Product Owner. "Its compact footprint, centralized wiring and intuitive start-up wizard optimize your efficiency, while providing uncompromised uptime and reliability." For more information, visit https://www.danfoss.com.

Pfannenberg Combines Free and Active Cooling in DHS Hybrid Series

Pfannenberg announced the DHS Hybrid Series (DHS 34X1). By combining free cooling with active cooling, this closed-loop system safeguards critical electronics within an enclosure while lowering energy consumption, cutting costs and reducing carbon emissions.

Free cooling minimizes energy use by using the cooler air outside the enclosure to remove heat from inside. Active cooling uses a refrigerant compressor and refrigerant cycle to cool the air in the enclosure when it exceeds the desired temperature. This combination optimizes the efficiency of the cooling unit, reducing energy usage. This dual system also provides redundancy in a single unit to avoid downtime, fits all full-sized enclosures and features an easy-to-read status display.

The DHS series is offered in indoors (Type 12), outdoors (Type 3R/4) and washdown (Type 4X) configurations. The product proves ideal for locations with lower ambient temperatures, climate-controlled facilities and operations that periodically run at partial capacity.

The DHS series meets high standards for electrical safety, being certified to the UL 60335 standard. The product has also been designed to meet upcoming environmental regulations governing the use of the R-513A refrigerant.

"The DHS-Series combines the best of free cooling and active cooling to radically impact an end-user's energy consumption and carbon emissions while cooling their critical electronics," said James Wong, Director of Global NEMA Product Management, Pfannenberg. For more information, visit https://www.pfannenbergusa.com.

EvapTech Gulf Services Opens Houston Office to Strengthen Service and Support Across the Gulf Coast Region

EvapTech opened EvapTech Gulf Services, a new office in the Houston area, to better serve customers throughout the Gulf Coast region. This strategic expansion reinforces the company's long-term commitment to supporting the energy, petrochemical, industrial and power generation markets concentrated along the Gulf Coast.

The EvapTech Gulf Services office will serve as a regional hub for sales, project management, engineering coordination and field service operations. By establishing a local presence, EvapTech enhances its ability to deliver faster response times, closer collaboration with customers and more efficient execution of both new construction and retrofit projects.

EvapTech specializes in the design, engineering and construction of field-erected cooling towers, as well as comprehensive repair, upgrade, reconstruction and parts services. As a wholly owned subsidiary of EVAPCO, the company combines decades of research-driven innovation with extensive field experience to deliver reliable heat transfer solutions.

The Gulf Coast region will encompass and focus on Texas, Louisiana and sectors of Mississippi, and is home to a concentration of refineries, chemical plants, LNG facilities and power stations. These industries rely on dependable cooling systems to maintain safe and efficient operations. The new Houston location positions EvapTech to respond quickly to project demands, outage schedules and emergency service needs throughout the region. With EvapTech Gulf Services, EvapTech also affords local support for critical efficiency upgrade evaluations.

As EvapTech continues to invest in growth strategies aligning with customer needs and industry demand, the EvapTech Gulf Services office underscores the company's commitment to delivering high-quality engineering solutions, local expertise and long-term partnership to the customers in this vital region. For more information, visit https://www.evaptechinc.com.

EvapTech Gulf Services building

NEWS Industrial Energy & Water Conservation

Aptar Group Again Recognized with Prestigious A Score on the CDP Climate Change Assessment

Aptar Group, a global leader in drug delivery and consumer product dosing, dispensing and protection technologies, was recognized for its leadership on climate change topics by the global environmental non-profit CDP, securing a place on its prestigious A List for the second consecutive year.

Aptar has established itself as a global leader in corporate environmental responsibility by taking measurable action on climate issues and demonstrating a strong commitment to transparency. Aptar was recognized for its actions to cut emissions, mitigate climate risks and further the low-carbon economy, based on the data reported by the company through CDP's 2025 corporate questionnaire. In 2025, over 22,000 companies disclosed environmental data through CDP. These companies represent more than half of the global market capitalization. By securing a place on the A List, Aptar is among the top 4% of the nearly 20,000 companies scored by CDP.

Aptar has set formalized science-based targets for Scope 1 and Scope 2 emissions reductions in line with requirements to keep global warming at 2.7°F (1.5°C) by 2030. In addition, the company has a renewable electricity target, as well as a Scope 3 target. Aptar's targets have been validated by the Science Based Targets Initiative (SBTi). In addition, Aptar received the ISO 14046 certification, assuring the reduction in greenhouse gas emissions in all scopes, especially as it increased renewable electricity purchases.

"It's promising Aptar's progress continues to be recognized by CDP. In a global landscape that continues to evolve, transparency and accountability remain essential. We believe it is important to openly share our progress with the world and demonstrate meaningful reductions in our carbon emissions. Our focus is on continuous improvement and close collaboration with our global teams as we continue our progress on our sustainability journey," said Beth Holland, Chief Sustainability Officer, Aptar. For more information, visit https://www.aptar.com.

THOR Industries Announces 36% Reduction in Scope 1 and 2 Emissions

THOR Industries, one of the world's largest recreational vehicle manufacturers, published its eighth annual sustainability report detailing the company's industry-leading sustainability efforts for its 2025 fiscal year across its global family of companies.

THOR has taken significant steps in its sustainability journey to lead the way for the RV industry. The introduction of the ENTEGRA COACH® EMBARK™, the world's first range-extended electric class A motorhome, illustrates the successful execution of THOR's eMobility strategy, helping drive lower GHG emissions by developing electric vehicles to reduce reliance on internal combustion engines.

In the report, THOR shares it has decreased global Scope 1 and Scope 2 emissions by 36% vs. the company's baseline FY2019. It has also decreased Scope 3 emissions by 42% globally vs. the company's baseline FY2022. The company submitted its fifth annual Carbon & Climate questionnaire to CDP to provide visibility and disclosure around efforts to measure, manage, disclose and reduce GHG emissions and water usage.

"At THOR, our sustainability efforts focus not only on creating more innovative products to minimize environmental impact while using our RVs, but also focus on improving our environmental and social impact within our operations, our value chain and in the communities where our team members live, work and play," said Bob Martin, President and CEO, THOR Industries. "We are committed to making changes now to ensure a sustainable future exists so people can continue to connect with nature, and families with one another, to create lifelong memories." For more information, visit https://www.thorindustries.com.

Aqualia Secures B CDP Rating, Strengthening Climate and Water Resilience

MDS Aqualia announced its parent company, Aqualia, has earned a B rating from CDP, formerly the Carbon Disclosure Project, the world's leading environmental disclosure authority. The rating recognizes Aqualia's strong performance in climate management and water security, two key areas tracked by global sustainability agencies, institutional investors and public regulators.

MDS Aqualia is the U.S. division of Aqualia, a global water and infrastructure company with operations in more than 20 countries. In Texas, MDS Aqualia supports water and wastewater infrastructure development through long-term partnerships, innovation and resilience-focused solutions.

This marks Aqualia's first year submitting independently to CDP, which assessed more than 20,000 companies on climate risk mitigation, operational transparency and environmental leadership.

As Texas faces prolonged drought, rapid population growth and aging infrastructure, Aqualia's recognition signals growing alignment with the region's most urgent water challenges. The CDP rating reinforces MDS Aqualia's commitment to providing local municipalities and industries with integrated, climate-resilient water solutions.

"This recognition confirms we are moving in the right direction and encourages us to continue promoting transparent environmental management aligned with global challenges," said Pedro Rodríguez, Director of Strategic Development and Sustainability, Aqualia.

MDS Aqualia continues to expand its work across Texas, supporting utilities and municipalities through water efficiency programs, climate adaptation and drought mitigation, resource reuse and circular economy models and smart water infrastructure and digital monitoring.

These initiatives align with Aqualia's broader commitment to reaching climate neutrality by 2050, and position the company as a strategic sustainability partner in the U.S. For more information, visit https://aqualiausalp.mdswater.com.

Scania Shares Progress Toward Sustainability Goals, Reporting Nearly 54% Reduction in Scope 1 and 2 Emissions

Scania, a Swedish manufacturer of heavy trucks, buses and engines, published its financial and sustainability performance for 2025. In a year marked by geopolitical turmoil, market uncertainty and currency headwinds, the company delivered resilient results and maintained its position as one of the industry leaders, with a continued strong market share in Europe.

Macroeconomic turbulence affected the transport industry in 2025. Demand declined in parts of Latin America, while in Europe it normalized after record levels in 2024. Toward the end of the year, customer confidence strengthened in Europe and order intake improved in the fourth quarter.

Scania secured a 17.6% market share in the European heavy truck market in 2025, despite an overall market decline, supported by short lead times and strong customer response to the Scania Super powertrain.

During the year, Scania simplified its organizational structure to reflect changing market conditions. The company continued to invest in electrification, charging solutions and industrial capabilities and strengthened its presence in China, an important market for long-term growth and innovation.

Scania has published its first Sustainability Statement, prepared in accordance with the European Sustainability Reporting Standards. Since 2015, the company has reduced Scope 1 and 2 emissions by nearly 54% and surpassed its Science Based Target for emissions from its own operations.

An electric Scania 45 R truck

"Meeting our 2025 Science Based Target for operational emissions is an important milestone for Scania. Over the past 10 years, we have reduced our CO_2 emissions from our own operations by half. This shows determined action delivers measurable results. At the same time, we remain focused on accelerating the transformation of the wider transport system, where the largest share of emissions occurs," said Christian Levin. For more information, visit https://www.scania.com.

Schneider Electric Turns Waste into Efficiency

By Anand Varahala, Director, Energy & Sustainability, Schneider Electric

➤ Schneider Electric's Lincoln, NE, facility manufactures miniature circuit breakers and molded-case circuit breakers. The plant operates around the clock and houses plastic injection molding, brazing, stamping and automated assembly lines. Prior to this project described in this article, the plant's process cooling water loop absorbed heat from injection molding, air compressors, compressed air dryers and brazing chillers and rejected it to the atmosphere through a heat exchanger and open cooling tower. Meanwhile, 23 air handling units (AHUs) used chilled water and steam (from gas-fired boilers) to provide the necessary cooling and heating to keep factory and office employees comfortable. In peak winter, the system struggled to maintain a comfortable temperature, especially along perimeter zones and dock areas, due primarily to the negative pressure and uncontrolled infiltration resulting from exhaust drawn out of the molding area.

Lincoln is one of Schneider Electric's most energy-intensive North American sites, making it a strategic priority for decarbonization and achieving our SBTi-validated net-zero commitment to reducing our operational (Scope 1 and 2) greenhouse gas emissions by 90% by 2030. A conventional, like-for-like electrification of the legacy steam-based heating would have required significant electrical upgrades and risked higher operating costs, an approach misaligned with our efficiency-first philosophy.

Above: Schneider Electric's Lincoln, NE, facility

Scoping and Feasibility, Q1–Q2 2023

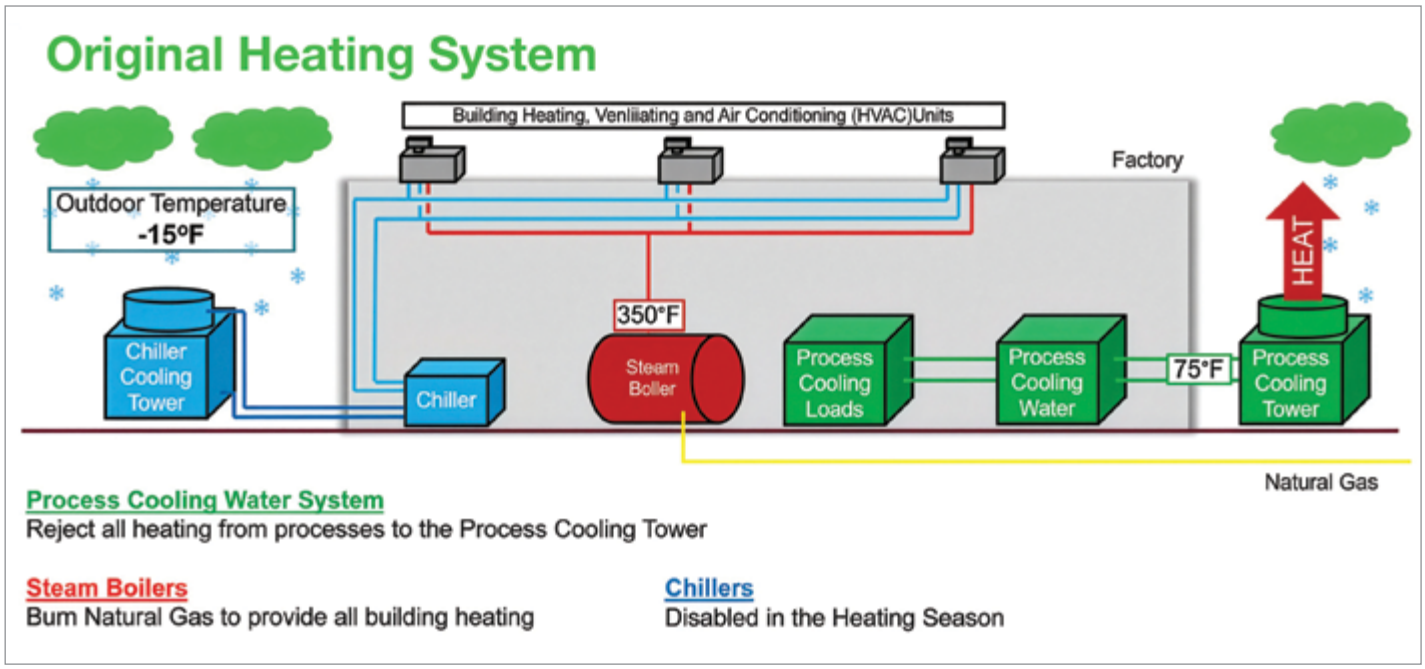
In early 2023, we initiated a feasibility study aimed at eliminating fossil fuels for comfort heating while minimizing grid impact. We teamed up with World Energy Innovations (WEI), an engineering and design firm dedicated to energy efficiency, to evaluate decarbonization pathways in Lincoln's cold climate, where winter temperatures can drop into the negative teens Fahrenheit. During the study, the team assessed thermal loads, building pressurization requirements and the potential to reuse existing equipment.

Key assumptions and baseline values for the study included baseline gas use for comfort heating of approximately 10,600 MMBtu/year, annual water consumption of 13.5 million gallons/year, average process-cooling water temperature at AHU coil inlet of approximately 75°F (24°C) and typical winter heating supply air temperatures of 65°-75°F (18°-24°C) at the coils.

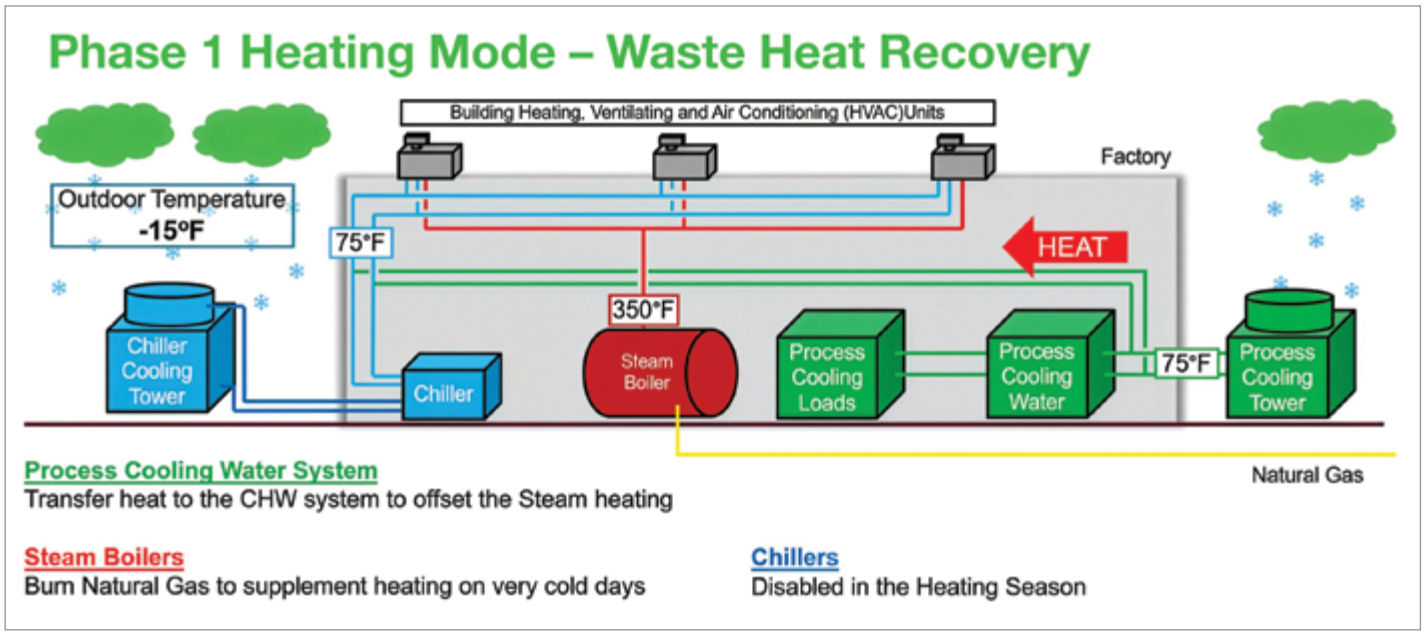
Design Decision, Q3 2023: Low-Temperature Heat Recovery

The team selected a low-temperature heat recovery strategy: Reuse the existing chilled-water coils within the AHUs to transfer process heat into the ventilation air using approximately 75°F (24°C) process cooling water as the heat source. Achieving meaningful heating with such low water temperature is only possible with precise building pressurization and air balancing. Positive pressure eliminates cold infiltration and allows low-grade heat to carry the comfort load across large manufacturing spaces.

Control was the linchpin, but it followed the mechanical design strategy. WEI engineered the design, defined by the thermal load requirements, and authored the sequence of operations that enabled 75°F (24°C) process water to reliably carry a significant portion of the winter heating load. This carefully engineered control sequence served as the digital backbone to blend outside air, return air and coil water temperatures dynamically, switch piping and valves between heating and cooling modes and coordinate the operation of fans and pumps across 23 AHUs, thus turning a static HVAC plant into a responsive, software-defined



A schematic of the pre-project system showing the process loop carrying heat to the cooling tower and a separate steam heating loop.



Phase 1 schematic showing the redirection of process water into CHW coils for heat recovery.

system. Where feasible, the design retained and repurposed legacy equipment to reduce costs and avoid unnecessary embodied carbon.

Design parameters included process cooling water used as the heating source at approximately 75°F (24°C) supply, with expected return of approximately 70°F (21°C) depending on load, and target positive building pressure of approximately 0.02–0.05 inches of water column, with outside-air reset by conditions.

Implementation and Commissioning, Q4 2023–Q1 2024

With the design phase complete, WEI advanced the project to execution by producing the detailed mechanical scope of work and controls specifications required for construction and system integration. We contracted NIFCO Mechanical to perform the mechanical and plumbing installation in accordance with the engineered scope, while Control Services, a Schneider Electric EcoXpert Partner, executed the controls hardware deployment and software programming essential for the building automation system. WEI maintained technical oversight throughout construction and integration activities, and the Lincoln plant's facilities team coordinated site access and activities to ensure all field work proceeded without disrupting production. WEI led the commissioning process, which included functional performance tests for pressurization sequences, valve switchover, airflow validation and heat recovery effectiveness. Control Services worked alongside WEI to implement

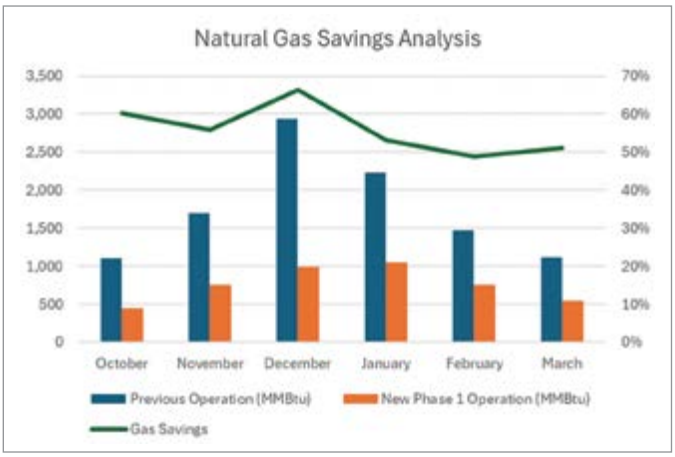
Schneider Electric Turns Waste into Efficiency

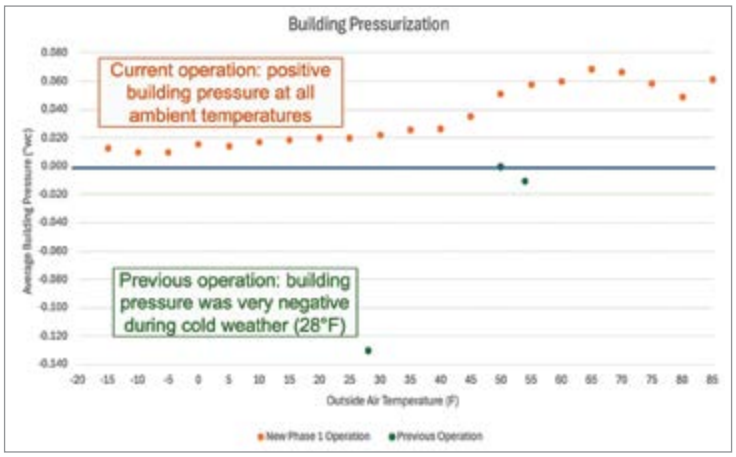
necessary changes in programming logic as determined during commissioning. Early procurement and tight coordination among partners mitigated long lead times for critical components.

Schneider Electric continued to leverage EcoStruxure Building Advisor's machine-learning analytics for proactive fault detection and continuous performance monitoring of the entire HVAC system.

First Heating Season: Winter 2024-25

Entering the 2024-25 heating season, the plant relied on low-temperature process water for comfort heating, supported by a newly tuned pressurization strategy, with the gas-fired steam





Charts show the positive effect Phase 1 had on building pressurization and natural gas use.

About Schneider Electric

Schneider Electric is a global energy technology leader, driving efficiency and sustainability by electrifying, automating and digitalizing industries, businesses and homes. Its technologies make the new energy landscape possible, enabling buildings, data centers, factories, plants, infrastructure and grids to operate as open, interconnected software-defined ecosystems, enhancing performance, resilience and sustainability. Its portfolio includes intelligent devices, software-defined architectures, AI-powered systems, digital services and expert advisory. With 160,000 employees and one million partners in over 100 countries, Schneider Electric is consistently ranked among the world's most sustainable companies.

Located in Lincoln, NE, Schneider Electric's Lincoln factory, one of the company's flagship manufacturing sites, is an advanced, high-volume operation combining precision engineering, world-class automation and deep manufacturing expertise. Established in 1971, the facility spans over 224,000 square feet of covered floor area, including a 157,000-square-foot workshop, 29,400 square feet of office space and an expanding warehouse footprint. Supported by a workforce of over 350 employees operating across multiple shifts, the Lincoln plant produces some of Schneider Electric's most essential residential and commercial circuit protection products, including QO/HOM one-pole thermal-magnetic breakers, QO electronic CAFI breakers and miniature MTS circuit breakers.

The Lincoln factory integrates a full spectrum of vertically connected manufacturing capabilities, including thermoset and thermoplastic molding, high-cavitation tooling, advanced stamping, automated welding and robotics-enhanced assembly. Dedicated molding operations run 24/7 across several BMC and phenolic presses (for thermoset plastics) and multiple thermoplastic systems, while stamping operations run 24/5. Automated assembly lines use multi-slide technology, vision inspection, robotic handling and poka-yoke and jidoka systems to ensure exceptional consistency and quality. Certified to ISO 9001, 14001, 45001 and 50001, the plant maintains rigorous standards for safety, quality, energy and environmental performance. With continuous improvement as a core discipline, the factory is actively advancing next-generation programs, including new breakers, Tesys-D development and additive manufacturing (3D printing). Together, these capabilities position the Lincoln facility as a high-performance, future-ready manufacturing hub at the heart of Schneider Electric's North American supply chain. For more, visit https://www.se.com.

Schneider Electric's Nashville hub

boiler as backup for cold winter conditions. Operators observed notably better thermal comfort in perimeter zones and the shipping/receiving docks. Indoor air quality improved as filtered outside air displaced uncontrolled infiltration and the building maintained a consistent, slight positive pressure. Another important contributor to improved indoor air quality was the ability of a positively pressurized building to feed the areas of the plant with process exhaust filtered (through AHUs) outside air, resulting in better containment of odors being exhausted.

Quantified outcomes for the first full winter included gas savings of approximately 6,000 MMBtu ($55,000), water savings of 4.5 million gallons ($45,000) and a reduction of Scope 1 CO_2 emissions by 360 tons. Recording its highest annual production level in 2024, the plant also benefited from steadier temperatures and improved ventilation in high-load areas such as injection molding.

Financial Performance: A Long Payback Period

Total project investment was $1.7 million. Annual utility savings to date are approximately $100,000, driven by reduced natural gas and water use and supported by operational efficiencies. On that basis, simple payback is approximately 17 years.

Just as important, however, are the non-energy benefits: healthier indoor air, fewer cold drafts and more stable conditions across the floor. Other material, but non-financial, benefits include greater employee comfort and reported productivity gains. Finally, the proven success of the low-temperature water heating enables the facility to proceed with its next phase involving a geothermal design using standard water-cooling chillers as heat pumps. These same chillers can add to summer cooling capacity and redundancy.

The project has earned significant recognition, including the U.S. Department of Energy's 2025 Better Project Award. The work has been showcased in DOE webinars and presented at the Association of Energy Engineers conference in Atlanta.

Phase 2: Geothermal System Fully Eliminates Fossil Fuels for Heating

Phase Two will integrate a geothermal field and new chillers acting as heat pumps in the winter to supply the necessary additional heat during extremely cold weather, fully replacing steam and enabling zero-CO_2 comfort heating. Leveraging the efficiency-first groundwork of Phase 1, the system will be right-sized to actual loads. Preliminary targets include supply water temperatures of approximately 75°F (24°C) to AHU coils and an additional Scope 1 reduction of roughly 330 tons of CO_2. Commissioning is projected for Q2 2027, with measurement and verification planned over the subsequent heating season.

The factory floor for Schneider Electric's Lincoln, NE, plant

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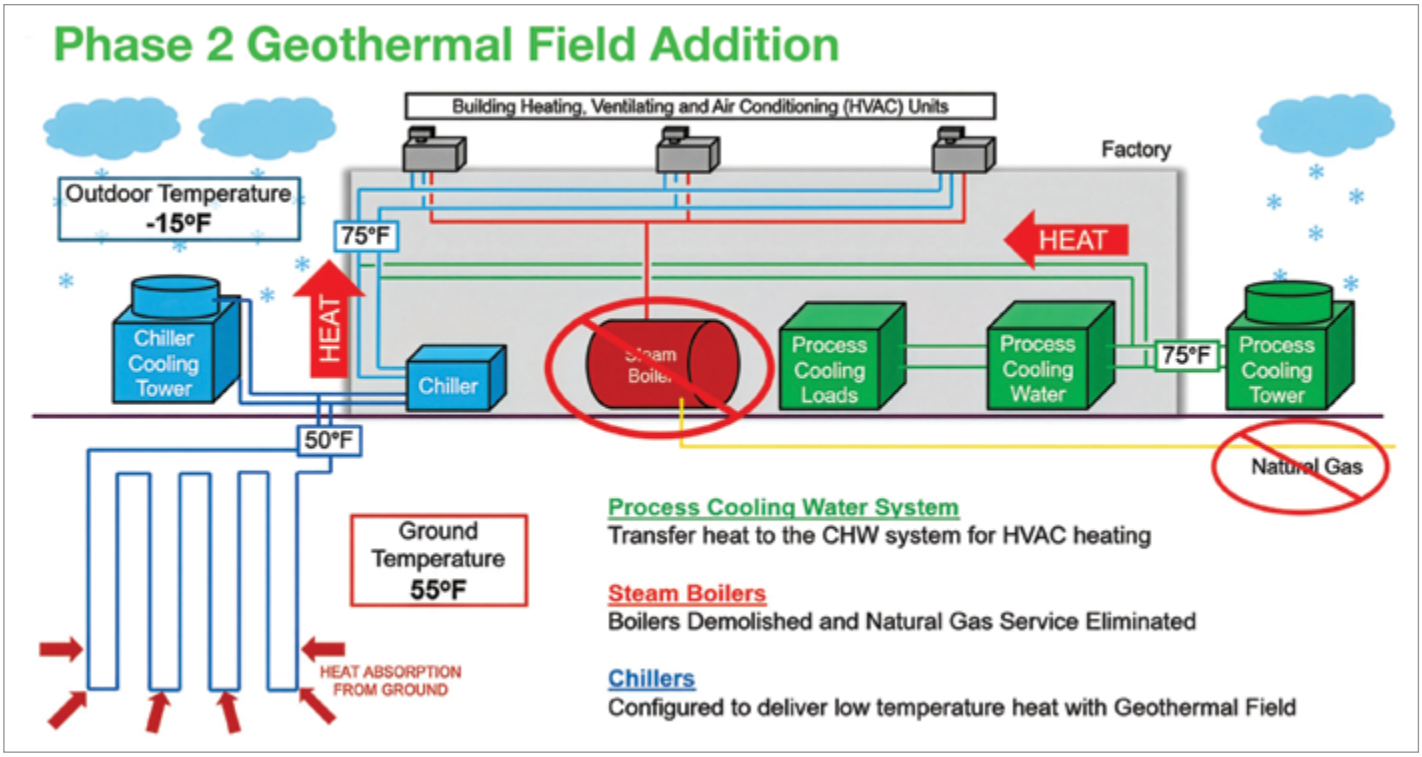

A conceptual diagram showing the flow of heat between a geothermal heat pump, process water, chillers, towers and AHUs.

Being one of Schneider Electric's highest energy-consuming sites in North America, gains at the Lincoln plant translate into meaningful impact. More importantly, the approach is replicable anywhere a facility has steady process loads and robust controls. Across Schneider Electric's large industrial plants, similar projects are being evaluated, collectively representing over 25% of the North American operational footprint. The lesson is clear: Start with low-temperature heat recovery and pressurization, design controls to do the heavy lifting and use digital analytics to keep performance on track.

WEI led feasibility, thermal load calculations, concept design for full electrification, detailed design of the waste heat recovery system, controls logic and system start-up and commissioning. Control Services implemented the control architecture, programming, sensor/automation server installation and worked with WEI for the commissioning of the building automation system. NIFCO Mechanical executed all mechanical and plumbing construction. Schneider Electric provided the digital backbone, including EcoStruxure Building Operation and EcoStruxure Building Advisor.

Lessons learned:

- Prioritize pressurization and air balance: Low-temperature heating rides on eliminating infiltration.
- Make controls the strategy: Sequences, resets and analytics deliver most of the value.
- Reuse what you can: Existing chilled water coils are excellent low-temperature water heating coils. Existing infrastructure can be a powerful asset.
- Plan commissioning and trending upfront; validate, tune and keep tuning.

Conclusion

The Lincoln project shows industrial decarbonization does not have to start with megawatts of new electrical capacity. By first reclaiming low-grade heat and using controls to make it useful, a factory can cut fuel consumption, improve comfort and build a solid runway for low-temperature heat pumps and deeper electrification. Perhaps most importantly, it demonstrates how an efficiency-first, data-driven approach can deliver both operational resilience and real momentum toward net-zero. BP

About the Author

Anand Varahala is the Director of Energy & Sustainability at Schneider Electric, focused on operational decarbonization across North America. He has over 17 years of experience delivering energy-efficiency, electrification and digital energy-management programs.

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Andrew Smith, P.E.
Co-Founder, SMARTCAir

May 7th, 2026

Uncovering Air Compressor Controls from Load/Unload to VFD Operation

Presenter Andrew Smith, P.E., Co-Founder, SMARTCAir – *Sponsored by VPInstruments and Rogers Machinery*

"This was very practical and beneficial. Our plant can implement some of these simple solutions to see immediate improvement."

– I/E Reliability Engineer, Qemetica US Silica

Don Van Ormer
Auditor, APEnergy

June 4th, 2026

Dryer Sizing: Load, Dew Point and Ambient Conditions

Presenter Don Van Ormer, Auditor, APEnergy – *Sponsored by Trace Analytics*

"Thank you, I learn from every one of these seminars. Staying in touch with the industry as I design."

– Engineer, ISG Engineers

Tony Lundell
Senior Director of Standards and Safety, International Institute of All-Natural Refrigeration

June 18th, 2026

Choosing the Right Low-GWP Refrigerant for Your Chiller Application

Presenter Tony Lundell, Senior Director of Standards and Safety, International Institute of All-Natural Refrigeration – *Sponsored by Johnson Controls*

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Understanding Compressed Air Load Profiles and Peak Demand Management

Presenter Mauricio Uribe, Head of European Operations, Compressed Air Consultants – *Sponsored by FS-Elliott and Rogers Machinery*

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– Civil Works Supervisor, Magna

July 16th, 2026

Dense vs. Dilute: Choosing the Right Pneumatic Conveying Method

Presenter Jonathan McPherson, Director of Advanced Manufacturing Research and Training, Kansas State University Olathe – *Sponsored by Kaeser Compressors*

July 30th, 2026

Condensate Management: Drains, Separators and Compliance Strategies

Presenter Peter Vinck, Senior Engineering Consultant, Inflow Corporation – *Sponsored by Clean Resources*

August 13th, 2026

How to Maintain Cooling System Efficiency Over Time

Presenter Clayton Penhallegon, Jr., PE, Principal Engineer, Integrated Services Group – *Sponsored by Nicotra Gebhardt*

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The CABP Interview: FS-Elliott CEO Everson De Campos on Centrifugal Air Compressor Engineering

By Troy Dreier, Senior Editor, Compressed Air Best Practices® Magazine

Roderick Smith, publisher of *Compressed Air Best Practices® Magazine*, sits down with Everson De Campos to talk about the CEO's goals, trends in oil-free compressed air and the rigorous engineering needs of centrifugal air compressors.

Everson De Campos was appointed CEO of FS-Elliott in February 2025, bringing fresh vision to the company. He has more than 25 years of experience in the compressed air industry, including 15 years with FS-Elliott's parent company, Fusheng Industrial Group. He played a key role in expanding engineering capabilities, manufacturing capacity and global business operations.

In February 2026, Roderick Smith, Publisher of *Compressed Air Best Practices® Magazine*, sat down with De Campos at the company's Export, PA, headquarters to hear how the company invests in its factory, meets demands from industrial customers with new services, develops new products and trains its sales channel. This continues our series of conversations with some of the most influential names in compressed air.

Factory Investment at FS-Elliott

Smith: Can you comment on your parent company, Fusheng Industrial, its commitment to the compressed air industry and its investments in compressed air manufacturing?

Above: CEO Everson De Campos with a Polaris P700 centrifugal air compressor at FS-Elliott's worldwide global headquarters in Export, PA.

De Campos: FS-Elliott is a proud member of the Fusheng Group, headquartered in Taiwan. Fusheng began in the compressed air industry, and air compressor manufacturing remains one of the company's core business pillars today. The organization has grown significantly and now employs more than 22,000 people globally, yet this segment remains a major strategic focus. As a result, the company continues to invest heavily in manufacturing, technology and global production capacity.

In recent years, Fusheng has made significant investments in industrial air compressor production, including new factories in India and China to increase production capacity and better support local customers.

At FS-Elliott, we continue to invest in our facilities in the United States, China and India, including new manufacturing equipment, building upgrades, digital infrastructure and research and development. Our goal is to maintain our technology leadership while continuing to strengthen our competitiveness and deliver greater value to our customers.

Smith: When you were announced as CEO in February 2025, you identified innovation, sustainability and digital advancements as key areas for growth. How have you focused on new product development here in Export, PA?

De Campos: Innovation is a major focus for us, and we believe it has to be part of both our future and our present. Our new product development team is constantly working on new technologies, new air compressor frames and new control systems.

Recently, we launched the Polaris P650 centrifugal air compressor, followed by the P650 DF with a dual-inlet configuration. We also have advanced controls in development and a strong pipeline of new products coming over the next several years. Many of these developments are driven by customer demand and evolving market requirements.

To support this development work, we have made significant investments in our headquarters facility, including expanding our five-axis machining capabilities, which are critical for manufacturing aerodynamic components.

Smith: Can you talk about those 5-axis machines? That's a major investment, right?

De Campos: It's a huge investment. The project involved not only purchasing the machines but also preparing the facility, installing the necessary power infrastructure and creating a dedicated machining area to support the equipment.

We offer multiple types of products, some more industrial, some more standard. Many are engineered to order, but for the standard ones, we're looking at large-scale pipe benders to help us minimize our welding and hydro tests. To cut our impellers, we made a huge investment in new Mazak machines.

Smith: You've had to invest in capital equipment and specialists to manufacture in volume.

De Campos: Investing in people is a strategic decision. As our business grows, we create new work areas and bring in more specialists to support manufacturing and engineering. Our business is engineering-driven, and the expertise of our people is one of our biggest strengths.

Almost every machine we sell is engineered to order. We have standardized industrial machines, but even with those, we still look at the customer's needs and ask, What's the range of temperatures in that area? What's the altitude? What's the required flow and pressure? We fine-tune and optimize the machines through our process, so even standardized air compressors are essentially engineered-to-order.

The Operations group has been investigating additive technology. Is that the future for us? The technology isn't ready yet, but we don't want to stop thinking about it. We know some companies create airplane bearings using 3D printers, so we have our own 3D printers. It's looking at the future. We don't want to be surprised by the future. We want to stay in the vanguard as a dedicated centrifugal business.

Service Innovations to Meet Customer Demands

Smith: In June 2025, FS-Elliott announced a Rapid Response Service Center to minimize customer downtime and improve sustainability by reusing airends. What other ways is your company prioritizing service and support?

De Campos: ESG [environmental, social and governance] and sustainability are important to us and to many of our customers, especially in industries like chemical, petrochemical and air separation. One of the biggest contributions we can make in this area is improving efficiency and extending the life of existing equipment.

We've made significant investments in high-efficiency products, and sustainability has really become part of our company's DNA. We also aim to make our headquarters carbon-free by 2030.

Another important part of ESG is lifecycle support. Customers don't always want to replace equipment; they want to keep their machines running efficiently for as long as possible. We continue to invest in our global aftermarket services to refurbish, renew and overhaul machines when needed. In many cases, we can restore performance and efficiency without requiring a full equipment replacement.

Local service is one of our company's key pillars, and that thinking led to the creation of our Rapid Response Storage program. At large refineries and industrial plants, facilities are large, and spare components can sometimes be lost, damaged or simply not available when needed. We started asking how we could help customers better manage critical components.

Now we can manufacture critical components in advance, like airends, test them, store them in a climate-controlled environment and have them ready to ship immediately when needed. We test the unit after production and again before shipment, and the warranty begins at shipment, not when it is stored. So it's more than just a Rapid Response Storage Center; it's really a reliability and asset management program for our customers.

Smith: FS-Elliott's push to refurbish and review older air compressors is a big departure from our past as an industry.

De Campos: When you take a look at air compressor technologies, there are incentives to replace rotary screw air compressors after a certain number of years due to depreciation and replacement cycles. But centrifugal air compressors are different; they are designed for a much longer service life, and the machines are not obsolete after 10 years. In many cases, you can restore efficiency and performance through refurbishment and upgrades, essentially bringing the machine back to like-new performance.

Our air compressors are designed with serviceability in mind, and from a maintenance standpoint, they are somewhat plug-and-play. The airend can be removed from the machine and shipped back to the factory for overhaul while the rest of the installation, piping, electrical and auxiliary systems remain in place. Once the overhaul is complete, the airend is returned and reinstalled. We can also perform certain overhauls in the field, which helps reduce downtime. This approach makes upgrades and overhauls easier, faster and more cost-effective for our customers.

Bill Smith, Regional Sales Manager, and Roderick Smith, Publisher, Compressed Air Best Practices® Magazine, with Everson De Campos, CEO, FS-Elliott (left to right) on FS-Elliott's manufacturing floor. Between them is a Mazak INTEGREX dual-spindle milling and turning center, part of the company's investment in advanced manufacturing.

The CABP Interview: FS-Elliott CEO Everson De Campos on Centrifugal Air Compressor Engineering

Smith: Very innovative.

De Campos: We're talking about full machines right now. Customers want spare air compressors, and they want us to store them.

We established this business model in the U.S. and are looking to expand it to China, Singapore and other locations. All components are tested and certified, and many can be shipped overnight when needed. The overall goal is to reduce downtime risk, improve reliability and provide better lifecycle support for our customers.

Smith: Do you have strategic account managers who get to understand specific companies and their needs across multiple campuses?

De Campos: We do. On the industrial side of our business, we work through channel partner managers who support our channel distribution partners and help them understand customer needs and applications.

In addition, we serve certain niche markets directly. For industries such as the chemical and petrochemical sectors, we have dedicated specialists who focus on those markets. They understand the applications, specifications and customer requirements, and they work directly with customers in those industries.

The Push for New Product Development

Smith: Your company's most recent release, the Polaris P650 DF, is for 30-50 psi applications. What's driving that strategy?

De Campos: The P650 DF was driven by customer demand. We started seeing more requests from industries such as pharmaceuticals and fermentation for higher flow at lower pressure, and our team decided to enhance the existing P650 platform to meet those requirements by developing a dual-inlet configuration to increase flow while maintaining the same footprint.

From an engineering standpoint, that was a significant challenge. You can't simply duplicate an air intake and expect performance to double. Our engineering team had to address aerodynamic challenges and optimize the design to deliver higher flow at lower pressure while still maintaining efficiency and reliability.

We're also seeing more companies focus on heat recovery and heat-of-compression applications. In some cases, our air compressors are efficient and don't generate as much recoverable heat as some customers would like. As a result, we've made design adjustments to better support heat-of-compression requirements while still maintaining high efficiency. Overall, many of our recent developments were driven directly by customer applications and energy-efficiency initiatives, particularly in heat recovery and lower-pressure, high-flow applications.

Smith: Have you seen an increase in demand in systems with HOC and the P650 DF's outlet temperatures?

De Campos: Yes, we're seeing the benefits. It's not a regional play; this is a global play. We initially thought mainly European companies were focused on heat recovery, but now we see it all across the globe.

Customers have demanded heat recovery from every part of the air compressor possible. We have specific designs for large U.S.-based companies that recover heat from the motor.

Smith: What are some other trends you're seeing with oil-free centrifugal air compressors?

De Campos: Demand for oil-free compressed air continues to grow as more companies understand the value and risk reduction it provides. In industries such as electronics manufacturing, oil-free, clean dry air has become the standard. We're seeing a significant expansion of electronics manufacturing facilities worldwide, and these companies require large volumes of oil-free air to protect their processes and products. For many of these customers, oil-free air is really a form of insurance; it helps protect product quality, reduce contamination risk and avoid costly production issues.

Smith: Are you seeing a growing trend in air compressor technology experts re-evaluating oil-free centrifugals and using them for intermittent demand and oil-free applications?

De Campos: The simple answer is yes. We are seeing increased demand as more companies understand the benefits of oil-free centrifugal air compressors. In many cases, customers start with one machine and, once they see its reliability and efficiency, expand their systems.

Customers also realize they can use one, two or three centrifugal air compressors instead of 15 to 20 rotary screws. We're also seeing more companies investing in people and expertise dedicated to centrifugal air compressor technology. The companies most successful in managing large compressed air systems are typically those making that transition and building that expertise.

Smith: Why are centrifugal air compressors a good match for heavy use applications like iron and steel, power generation and petrochemical, beyond flow and volume?

Kyle Kelly, Airend/Service Assembler; Everson De Campos, CEO; Dan Kelly, Airend/Service Assembler, and Justin Johnson, Director of Product Management (left to right), at the Rapid Response Service Center.

THE EFFICIENCY THAT NEVER STOPS PAYING OFF

In continuous-duty industrial environments, energy is often your largest operating expense. That's where true centrifugal performance makes the difference.

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The CABP Interview: FS-Elliott CEO Everson De Campos on Centrifugal Air Compressor Engineering

De Campos: Heavy industries such as iron and steel, power generation and petrochemicals typically operate continuously and require highly reliable equipment. Centrifugal air compressors are well-suited for these applications because they're designed for continuous operation, high reliability, long service life and relatively easy maintenance, which is critical for facilities that cannot afford downtime. For example, our air compressors feature a horizontally split, field-serviceable airend design, which allows maintenance to be performed more quickly and efficiently without removing the entire air compressor from service.

Everson De Campos with an FS-Elliott centrifugal air compressor airend.

Another advantage is the footprint. These facilities dedicate most of their space to the production process, so the air compressor system must deliver large volumes of air in a relatively compact area. Centrifugal air compressors can produce high volumes of air while maintaining a smaller footprint compared to many other technologies.

They also provide oil-free air, stable operation and high efficiency. Overall, centrifugal air compressors are a strong fit for heavy industrial applications because of their reliability, efficiency, compact footprint, ease of maintenance and long-term operating life.

Smith: Space used to not be a big deal in these places, right?

De Campos: In many cases, our air compressors are installed as part of a larger process module within the plant. While these facilities may appear to have a lot of land, most of that space is dedicated to production, not to utilities like compressed air. Because of that, the footprint becomes important. Our centrifugal air compressors are compact, oil-free and capable of producing large volumes of air. For industries like iron and steel, the footprint and air volume are important, and for petrochemical applications, it's also our ability to meet strict industry specifications such as API, JIP and other industry standards.

Smith: Some of your customers have critical operations where cybersecurity is a concern. They may prefer wired control and monitoring solutions that don't use the cloud. How can your customers take advantage of IIoT monitoring solutions without creating risk?

De Campos: Cybersecurity is a major concern for many of our customers, and we take that seriously. Industries like chemical and petrochemical typically have strict policies regarding data security and system access.

Many customers prefer to maintain control of their own data and monitoring systems, and we support that approach. We can provide monitoring technology that allows customers to collect and manage their own data locally without relying on cloud-based systems.

In some cases, customers allow remote monitoring but not remote control. In those situations, we can monitor equipment performance and send alerts or service recommendations through cellular data as needed, while the customer maintains full control of the equipment.

Ultimately, the solution depends on each customer's cybersecurity policies, but our goal is to provide monitoring and IIoT capabilities while still allowing customers to maintain control of their data and operations.

Investments in Compressed Air Sales Channel Training

Smith: New distribution partners are given the opportunity to participate in the FS-Elliott

The U.S. Navy Talent Pipeline Program

FS-Elliott participates in the U.S. Navy Talent Pipeline Program (TPP), a national workforce development initiative helping advanced manufacturers strengthen their ability to attract, train and retain skilled employees. The program is part of a broader effort to reinforce the U.S. industrial and defense manufacturing base by building sustainable talent pipelines in critical industries.

Through the program's structured framework, FS-Elliott is enhancing recruitment, onboarding and career-development practices for high-skill manufacturing roles essential to compressed air equipment production, including precision machining, assembly, testing and service engineering. Participation also connects the company with regional educators and workforce partners, supporting pathways into advanced manufacturing careers.

By investing in workforce development alongside technology and innovation, the company helps ensure the long-term capability, reliability and competitiveness of U.S. compressed air manufacturing. The company's involvement reflects a broader commitment to operational excellence, employee growth and strengthening the skilled-trade ecosystem underpinning industrial productivity.

University Sales Training Program. What strategies for oil-free compressed air growth and development do you focus on with new distribution partners?

De Campos: This program evolved from the days when we would bring distributors to a hotel for classroom training. Over time, we realized our facilities and people are among our best-selling assets. When partners visit our factories and meet our engineers, product managers and service teams, they gain a better understanding of what we do and what makes our solutions different.

That's why we moved much of our training to our manufacturing facilities in Export, PA, and Shanghai, China, and developed a structured curriculum through our FS-Elliott University program combining classroom instruction with hands-on training. The sessions are led by our internal experts, and the training extends well beyond product knowledge.

We not only teach channel partners about centrifugal air compressors; we also teach them how to approach different industries and applications. For example, working on a pharmaceutical project is different from working in electronics manufacturing or at a petrochemical plant project. We focus on helping them understand customer applications and how our engineered-to-order capabilities solve specific problems.

The more our channel partners understand our capabilities and applications, the smoother projects run and the easier it is to differentiate our solutions. Developing that centrifugal mindset is important, especially for people who come from the rotary air compressor world, and I came from the rotary side myself, so I understand that transition.

Smith: So your university is growing? A lot of people are coming into this building?

De Campos: Yes, and our goal is to continue expanding the program. As a company, we're proud of our people and our capabilities, and bringing partners to our facilities helps build strong relationships. When people visit, they get to know our engineers, product managers, service technicians and leadership team, and that creates a much stronger working relationship.

Those relationships also help projects move more efficiently because people know who to contact and how to work together. It reduces delays and helps us support customers more effectively.

Smith: There's so much power when they understand the detailed, engineered features available. It just takes time to become aware of it all.

De Campos: They understand certain specifications are critical, and sometimes missing one small detail in a specification can create major challenges later in a project.

We have a Document Control department that creates the documentation package for every order. Every valve must be certified, every sensor must be documented, and, in many cases, the manuals can run to over a thousand pages. All of that documentation and certification gives our customers peace of mind, especially in industries with strict engineering and compliance requirements.

Our engineering capabilities support customers worldwide. We pride ourselves on meeting the most demanding customer specifications and requirements. You name it. We're not on Mars yet, but maybe soon. We work with the toughest engineering companies and meet their demands. Centrifugal air compressors require a different level of engineering, and we have the best people in the industry to support those requirements.

Images courtesy of FS-Elliott.

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Brandon & Clark Supports West Texas Silica Mining

By Troy Dreier, Senior Editor, Compressed Air Best Practices® Magazine

In industrial facilities dependent on compressed air systems, the ability to diagnose system problems, engineer practical solutions and maintain equipment over decades becomes as important as the hardware itself. That approach has defined the work of Brandon & Clark, a compressed air system engineering and service company serving industry in West Texas.

Two case studies illustrate the success the company has had in providing reliable compressed air in challenging situations. In the first, the company was called on to reduce maintenance demands for the compressed air system in a silica mine, a harsh environment where ambient air is extremely dusty, even with quality filtration. In the second, the company needed to disassemble and reassemble a 300 hp air compressor in a confined space, while keeping the warranty intact.

A 75-Year History of Mechanical Service in West Texas

Founded in 1950, the company began as a motor repair facility serving the electrical and mechanical needs of regional industry. Over time, the business expanded into multiple technical disciplines, including compressed air systems, electrical services and mechanical infrastructure support. The company's current structure reflects its multi-disciplinary heritage.

"The company is a multi-division industrial service company with deep roots in Texas industry," said John Curtis, Compressor Department Manager, Brandon & Clark. "We support our customers across compressed air systems, electrical services and mechanical infrastructure. Within our industrial air compressor services department, we specialize in engineering installations, maintenance programs, system optimization and OEM-supported technical execution."

The company's long history of service has shaped its operational philosophy. Rather than treating projects as one-time equipment sales, the organization maintains long-term technical relationships with customers, providing for maintenance, troubleshooting and system upgrades.

"One of the key things setting us apart from everybody else is if we sell something, we also want to be able to service it," Curtis said. "Everything we sell, we can also service. That

Above: Silica mining operations like this one present one of the most difficult environments for compressed air equipment.

might be an electric motor, a power transformer, a VFD or an air compressor. Every one of those things can be supported by our technicians. The goal is to be a single source for our customers. If you bought it from us, you can call us if there's a problem."

The company's service-focused model often places its technicians in environments where compressed air systems operate under demanding conditions. Two recent projects illustrate how the company applies engineering expertise and operational analysis to improve compressed air reliability in complex environments: a silica sand production facility in West Texas and a Texas university infrastructure plant supplying compressed air to research laboratories.

Silica Mining Is a Harsh Environment for Compressed Air Systems

Silica mining operations present one of the most difficult environments for compressed air equipment. The airborne particulates generated during mining, screening and handling processes create a persistent contamination risk for rotating equipment and heat exchange systems. At a silica mine in West Texas, the company works with a mining operator producing silica for oil and gas applications.

"The sand it produces goes primarily into the oil and gas industry for fracking and drilling operations. In geological terms, the material it extracts has to meet specific composition requirements for those uses. It's not just dirt. It has to meet compaction and material characteristics for hydraulic fracturing," Curtis said.

The facility extracts sand from a geological formation and processes it for use in oilfield operations. During production, heavy equipment excavates the material, after which the sand moves through a network of conveyors, pneumatic transfer systems and mechanical processing equipment. Compressed air supports several stages of the process.

"In this facility, compressed air helps run some of the pneumatic processes in the mining operations," Curtis said. "It's not breathable air. It's strictly for equipment use. Compressed air is used for drilling equipment, conveyor systems and some pneumatic presses. Some of the conveying equipment is pneumatic conveying tubing, where the material moves through tubes, and some of the transport is traditional conveyor belting."

Dusty Ambient Air Inside the Compressed Air Enclosure

The compressed air system at the facility consists of four direct-drive, oil-injected rotary screw 100 horsepower (hp) air compressors. The machines operate in parallel. "There are four 100 hp rotary screw compressors," Curtis said. "Three of them operate on constant load and one acts as a backup unit."

The compressed air passes through a central air treatment system, including a desiccant compressed air dryer and compressed air storage tanks.

"The system has a wet tank and a dry tank, and there's a single large desiccant dryer handling the air treatment," Curtis said. "It's a PSA desiccant dryer for drying the compressed air before distribution."

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> — John Curtis

The air compressor installation is located inside an enclosed structure providing partial environmental protection for the equipment. However, the building does not function as a tightly controlled mechanical room.

"The air compressors are inside an enclosed building, but it's more like a shed," Curtis said. "It's not a highly controlled environment. There's a roll-up door and a standard man door. Even with everything closed, the ambient air is extremely dusty."

Silica Particulate Infiltration and Mechanical Failures

When Brandon & Clark began servicing the site, the compressed air system was experiencing frequent failures. Those failures weren't the result of design flaws in the air compressors themselves, but rather the result of the operating environment created by the mining process.

"In a sand production facility, the environment is not mildly dusty. It's operationally abrasive," Curtis said. "The silica dust is extremely fine. It's almost like talcum powder." That particulate contamination created multiple operational problems. "Heat exchangers were getting clogged, discharge temperatures were increasing and the compressed air dryers cycled more frequently than they should. Filters were failing almost weekly. Fine particulate infiltration was occurring everywhere, even inside the control cabinets. That kind of contamination affects almost every component in the compressed air system."

The compressed air enclosure was built with ventilation features intended to reduce contamination. "Whoever engineered the original compressor room actually did a pretty good job," Curtis said. "There's filtered intake air on one side of the building and exhaust airflow on the other side. The idea is to pull air across the air compressors."

Despite those design features, however, the sheer volume of airborne silica generated by the mining operation made contamination unavoidable. "Even with all the doors closed, there can be half an inch of silica dust on the floor," Curtis said. "It's almost impossible to keep that environment clean."

Compressed Air System Evaluation Looks for Root Causes

When Brandon & Clark began working with the mining company, the first step was a comprehensive system evaluation.

"We spent about a week on site evaluating the system," Curtis said. "We looked at compressed air pressures at different times of the day, examined its maintenance program and analyzed where the sand intrusion points were. We evaluated airflow inside the air compressor room, clearances around the machines and whether there was enough space for maintenance and ventilation. We also looked at the airflow path. Was the ventilation actually moving air across the air compressors or was it just circulating at the top of the room?"

Technicians attempted to correlate operational events with air compressor failures. "We looked for patterns," Curtis said. "For example, does a certain type of activity in the plant create more dust? Does truck traffic stir up more particulate

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that enters the air compressor building? We tried to identify a root cause."

Ultimately, the analysis concluded the mining process itself was the dominant source of contamination. "We determined there really wasn't a single contributing factor," Curtis said. "It was simply the nature of operating a sand plant."

Moving to More Frequent Compressed Air System Maintenance

Because environmental conditions could not be significantly improved, the company focused on modifying the maintenance strategy. Initially, the facility followed a conventional maintenance schedule including monthly preventive maintenance visits and quarterly inspections.

The Texas university's disassembled 300 hp air compressor was reassembled at this location, replacing an older 300 hp air compressor.

However, that schedule proved insufficient in the highly abrasive environment.

"We moved from monthly preventive maintenance and quarterly inspections to a bi-weekly service schedule," Curtis said. "Instead of reacting to failures, we wanted to prevent them. We highlighted a service model shift from being a vendor to being an operational partner. Rather than just responding to problems, we focused on keeping the air compressors operating continuously."

Technicians began visiting the site every two weeks to perform maintenance, inspect components and clean contamination from the equipment. "In that environment, the only way to keep the air compressors operational is to clean them constantly. Fine particulate accumulation happens quickly."

Preventive Maintenance Saves $90,000 in Service Costs in Six Months

The results of the change were immediate. "I don't believe we've had any unplanned downtime since moving to bi-weekly preventive maintenance," Curtis said. The financial impact of the reliability improvement was substantial. Mining operations operate on continuous production schedules, so air compressor failures quickly affect revenue.

"We calculated that downtime was costing the facility roughly $4,000 to $4,500 per hour," Curtis said. "That was based on its sand production rate and the value of the material it produced."

In addition to preventing lost production, the new maintenance program reduced service costs. "Just by shifting from emergency repairs to scheduled maintenance, it's saving around $90,000 every six months in service and repair costs," Curtis said. When lost production was included in the analysis, the savings were significantly larger. "When we included the avoided downtime, the estimated savings were about $1.5 million per year."

For the company, the project demonstrated the value of forming a partnership with customers. "When we say we want to be an operational partner, what that means is we focus on making sure the customer is operating as efficiently as

possible," Curtis said. "We're not there just to sell equipment or perform a single service."

Instead, the company focuses on sustaining the customer's production systems. "We want the equipment to run as if it were our own facility," Curtis said. "If our customers are successful, then we're successful."

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A 300 hp Air Compressor Installation in a University Basement

While the mining project focused on environmental reliability challenges, another Brandon & Clark project will require extensive logistical and engineering planning to solve a different type of problem: installing a large air compressor in a confined facility. The customer is a research university in West Texas operating a central compressed air system serving laboratories and research facilities, and the project was nearing completion at the time of this interview. The company has maintained the university's compressed air infrastructure for decades.

"They're an existing customer of ours," Curtis said. "We've worked with them for probably at least 40 years." Over that time, the company has supported a wide range of maintenance and engineering tasks. "We've helped troubleshoot, maintain and install all of its air compressors. We also do electrical work out there, including controls integration, VFDs and PLC work."

The air compressor installation is located in a campus infrastructure building functioning as a mechanical hub for the university. "The air compressor is located in its infrastructure facility," Curtis said. "That building handles air and water systems for the campus. It's like a small city." The compressed air system supplies multiple types of users in nearby buildings.

"The compressed air feeds research facilities, laboratory equipment, pneumatic controls and the university's maintenance infrastructure," Curtis said. Some of the compressed air is distributed to other buildings through underground piping. "There's a network of compressed air piping branching out from the building. Some nearby research facilities receive compressed air from that central system. The air compressors run 24 hours a day."

Space Constraints Call for an Open Frame Air Compressor

The air compressor room contains three oil-lubricated rotary screw air compressors, one 300 hp and two 200 hp. Two of those air compressors operate continuously under heavy load.

"The 300 hp air compressor and one of the 200 hp air compressors run fully loaded most of the time," Curtis said. "The other 200 hp air compressor serves as a backup." The new installation involves replacing the aging 300 hp air compressor with a new air compressor with a similar capacity.

The original 300 hp air compressor had been in service for decades and experienced repeated failures. "The machine is probably 20 to 30 years old," Curtis said. "It had gone down numerous times." Maintenance costs had increased significantly as components wore out. "We were rebuilding airends, replacing coolers and changing parts almost every year. The cost of maintaining the machine had become higher than replacing it." After analyzing operating costs, the university decided to replace the air compressor with a new unit.

The selected replacement is a 300 hp open-frame, direct-drive, oil-lubricated rotary screw air compressor. "At 125 psi it produces about 3,400 cfm," Curtis said. The open-frame design is necessary due to space constraints in the mechanical room. "An open-type air compressor has no cabinet. That makes it easier to maneuver components during installation."

A Four-Foot Opening Presents Installation Challenges

The most difficult part of the project wasn't selecting the air compressor, but getting it into the building. The air compressor room is located in a basement with limited access.

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Brandon & Clark team members Nicholas Escobar, Service Coordinator; Tanner Haire, Technician; Brandon Goodwin, Technician; Zackary Estrada, Technician; Chad Carpenter, Lead Supervisor; Israel Rodriguez, Technician, and John Curtis, Compressor Department Manager (left to right).

"The basement has extremely limited entry points," Curtis said. "The main access opening is roughly the size of a manhole, measuring approximately four feet across." Historically, equipment had been lowered into the basement using an exterior lift gate. However, that lift system is no longer operational, and repairing it is not financially feasible for the project.

"Fixing the lift gate would have been outside the budget parameters for the project," Curtis said.

Because the air compressor could not be lowered as a complete unit, Brandon & Clark collaborated with the OEM engineering team to develop a disassembly and reassembly strategy. "From the beginning, we worked directly with the OEM engineers," Curtis said. "We explained the restrictions and constraints and asked them to help us develop a solution." The planning process involved months of engineering analysis. "We spent about two weeks initially determining whether the project was even feasible. After that, the full planning process lasted seven to eight months."

> *"Normally, if you disassemble an air compressor beyond certain components, you risk voiding the warranty...The OEM engineers developed a plan allowing us to disassemble and reassemble the unit while maintaining the warranty."*
>
> — John Curtis

During that time, engineers analyzed the air compressor's structure and determined how it could be safely disassembled without voiding the manufacturer's warranty.

"Normally, if you disassemble an air compressor beyond certain components, you risk voiding the warranty," Curtis said. "In this case, we needed to remove the frame sections and structural components. The OEM engineers developed a plan allowing us to disassemble and reassemble the unit while maintaining the warranty."

The installation plan involves separating the air compressor into several major components. "The motor, the airend, the cooler, the sump tank and the control cabinet all have to be lowered separately," Curtis said. The structural frame will also be divided into sections.

"The base frame has two sections," Curtis said. "There's the main base and an elevated base that supports the motor and airend." Each component will be lowered through the manhole using a jib crane. "The components will be lowered into a receiving area in the basement." From there, technicians will move the parts through a narrow service corridor.

"There's a walkway that's about five feet wide in some places. That's the tightest area after the manhole entry."

On-Site Air Reassembly of 300 HP Air Compressor

Once all air compressor components are delivered to the air compressor room, technicians will reassemble the machine. "The base frame will go in first," Curtis said. "Then we'll install the raised base with vibration isolators." After the frame is assembled, the main mechanical components will be installed. "The airend and motor will be mounted together with the direct drive housing. Next, we'll install the intake filters, the sump tank and the cooler. The control panel will be installed last."

Technicians from Brandon & Clark and the OEM will work together during the installation. "It will be a joint effort between our team and the OEM technicians," Curtis said.

After installation, the air compressor will integrate into the university's existing compressed air network. The system already includes air treatment equipment and distribution infrastructure. "There are two desiccant compressed air dryers in the compressed air system and multiple receiver tanks," Curtis said. The company will continue providing maintenance for the entire compressed air installation. "We perform preventive maintenance at least once a month."

Long-Term Compressed Air Reliability Objectives

For both the mining project and the university installation, the underlying objective remains the same: providing a reliable compressed air supply in demanding environments.

In the mining facility, that meant adapting maintenance practices to harsh environmental conditions. In the university facility, it means engineering an installation strategy that allows modern equipment to be installed in a confined space. Together, the projects illustrate how compressed air reliability often depends as much on engineering and operational expertise as it does on equipment selection.

As Curtis noted, the company's approach focuses on long-term operational success. "We're not there to sell one piece of equipment and walk away," he said. "We want those compressed air systems running as efficiently and reliably as possible. If the customer's operation succeeds, then we succeed." BP

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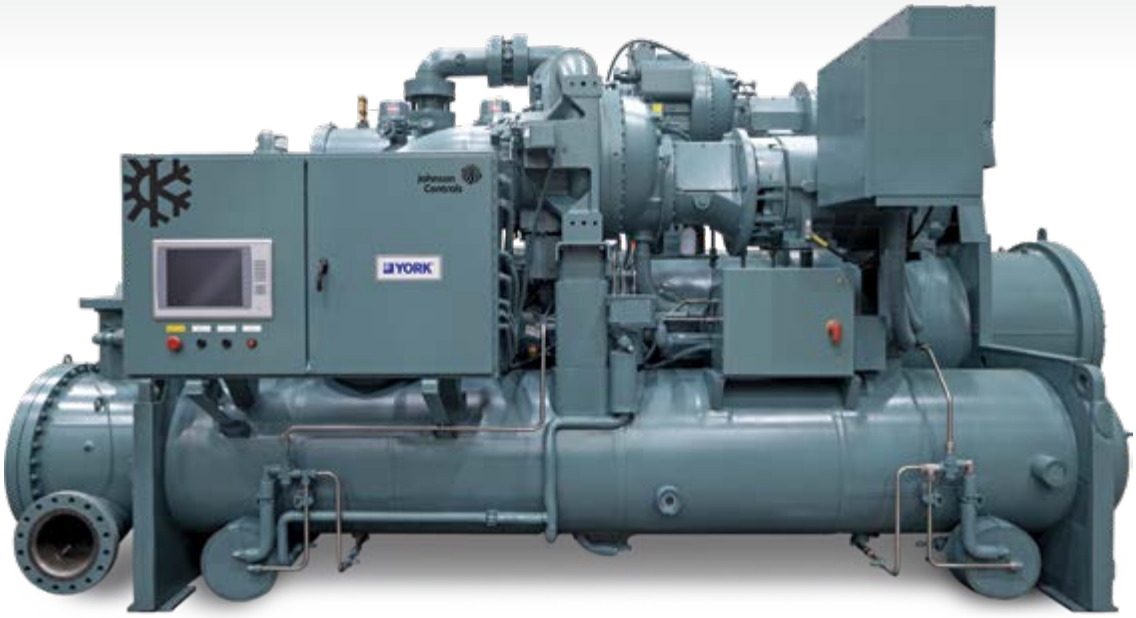


High-performance Process Cooling for Heavy Industry

By Rob Tanner, Director of Marketing, Applied Equipment, Johnson Controls

In heavy industry, process cooling is undeniably complex. Sectors such as petrochemical processing, metallurgy and heavy machinery manufacturing often require multiple processes operating under continuous, high-temperature loads. In many applications, process temperatures can exceed 1,000°F (538°C), and some equipment – such as steel blast furnaces and cement kilns – can run well above 2,000°F (1,093°C).[1] The thermal intensity and continuous nature of these processes demand cooling systems that can reliably manage extreme loads without compromising production, safety or equipment lifespan.

To meet these demands, many legacy cooling systems were designed around intentionally oversized chillers with limited ability to respond to changing operating conditions. This inability to adapt often restricted the system's potential to drive efficiency and reduce operating expenditures (OpEx) because more energy was used than was necessary. Even when the refrigerant compressor load was reduced, the chiller was required to maintain the same output tonnage value. As a result, reduced loads typically required the use of pre-rotation vanes on the inlet of the refrigerant compressor to reduce capacity by mechanically choking the flow of refrigerant gas.

As federal and state regulations evolve and energy costs fluctuate, many heavy industry leaders are seeking new solutions able to deliver the same unwavering performance of legacy systems while helping achieve efficiency and OpEx goals.

With advancements in centrifugal water-to-water chillers and heat pumps, operators can take advantage of technologies such as variable speed drives (VSDs), two-stage refrigerant compressors and on-board smart controls to enhance process cooling efficiency and performance. These innovations allow cooling systems to dynamically adjust to fluctuating loads and ambient conditions. In turn, these optimized systems provide a practical path to drive efficiency, reduce OpEx and maximize reliability. Today's chillers not only empower heavy industry leaders to reimagine what is possible within process cooling, but they also create a framework to achieve operational excellence.

Above: A YORK® CYK-400 Water-to-Water Compound Centrifugal Heat Pump Chiller

Thinking Beyond Chiller Tonnage

Chiller tonnage represents the maximum rate at which heat can be removed from a process. Traditionally, process cooling designs have focused nearly exclusively on tonnage and engineering equipment for peak conditions. Intentionally oversizing chillers is often an attempt to mitigate risk during the most extreme conditions. But, because most plants are not consistently operating at full load – even the steadiest processes will fluctuate during seasonal weather changes – opportunities to drive efficiency and reduce operating costs can be left untapped.

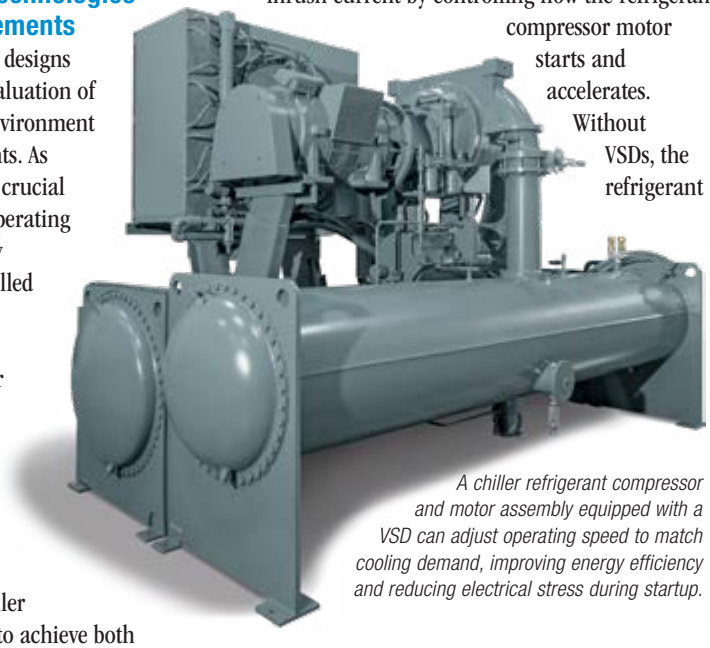
Although specifying chillers to ensure adequate heat removal during peak demand is crucial, it is also important to understand how chiller performance can impact the collective goals of the facility. In today's business environment, heavy industry plants face growing constraints to increase energy efficiency and reduce emissions.

Forward-thinking operators and systems engineers are incorporating tonnage as one of a multitude of factors to deliver reliable process cooling while achieving meaningful progress toward operational goals. Chillers are designed around dynamic, real-world conditions,

including production schedules, process types and seasonal temperature changes. Oversized cooling systems are replaced by right-sized and redundant designs. And technologies like VSDs, heat pumps and smart controls are integrated to enhance efficiency and deliver ROI.

Matching Chiller Technologies to Process Requirements

Modern process cooling designs begin with a holistic evaluation of the plant's operating environment and process requirements. As part of this strategy, it's crucial to clearly understand operating temperatures and lift by defining the leaving chilled water (LCHWT), return chilled water (RCHWT), leaving condenser water (LCWT) and entering condenser water (ECWT) temperatures. Evaluating these four temperatures together can help accurately determine the ideal chiller technologies necessary to achieve both the intended process cooling and performance outcomes of the plant.



A chiller refrigerant compressor and motor assembly equipped with a VSD can adjust operating speed to match cooling demand, improving energy efficiency and reducing electrical stress during startup.

Lower lift requirements can increase annual efficiencies. The Department of Energy estimates that just a 1°F (0.6°C) increase in chilled water temperature or a 1°F (0.6°C) decrease in condensing water temperature can improve chiller efficiency by approximately 1.5%.[2] However, flow rate can also have a significant impact on these outcomes. This requires careful evaluation of the level of head pressure control needed to provide full capacity. Head pressure control restricts water flow through the chiller's condenser tube bundle, causing the LCWT to rise and, in turn, lift to increase.

VSDs are another option for significantly enhancing chiller efficiency. This technology continuously fine-tunes motor and impeller speeds, allowing the refrigerant compressor to precisely match operating conditions at any given moment. Compared to traditional, constant-speed chiller designs, VSD provides a more dynamic response to changing load conditions. Instead of cycling the refrigerant compressor on and off or relying on mechanical throttling, VSDs gradually reduce speed to precisely match cooling capacity with the actual load demand. This allows the chiller to effectively reduce energy use during part-load conditions and even enhance efficiency during full-load operation when outside air temperatures fall below the designed wet bulb conditions.

Integrating VSD technology also helps manage inrush current by controlling how the refrigerant compressor motor starts and accelerates. Without VSDs, the refrigerant compressor requires a high electrical surge to quickly reach the intended speed. This can create temporary voltage drops in the plant, place electrical stress on the motor windings and reduce the refrigerant compressor lifespan. In comparison, VSDs provide a controlled acceleration curve, allowing the refrigerant compressor to gradually ramp up or down. This reduces stress on the motor and refrigerant compressor. It can also help reduce the required size of the on-site electrical grid and transformers necessary to prevent large voltage dips during a typical inrush event. Combined, these advantages can reduce both equipment first-costs and operating expenses while also minimizing maintenance requirements.

Single-stage vs. Two-stage Centrifugal Refrigerant Compressors

Understanding process cooling lift can also help dictate whether a single- or two-stage chiller is ideal for the application.

In processes with a higher lift, a two-stage chiller may be more advantageous, especially for operators focused only on full-load design efficiency. Two-stage chillers use two impellers

High-performance Process Cooling for Heavy Industry

to manage high-lift operations. Each impeller shares the load. In some cases, a flash economizer, or intercooler, is integrated between the impellers. This allows the refrigerant to be cooled partway through the cycle, reducing the exertion on the second impeller.

In some equipment designs, the function of a two-stage compressor can be accomplished using two single-stage drivelines in a compounding arrangement to achieve a higher lift. Each refrigerant compressor has its own motor and drive system providing modular control. If the lift is slightly reduced, the refrigerant compressors can modulate load and speed with VSDs to gain the maximum efficiency. If the lift drops significantly, the high-side refrigerant compressor can turn off, allowing the chiller to operate like a single-stage design and maintain efficiency. This dynamic capability ensures efficiency is retained during fluctuating lift conditions.

Heat Pumps and Waste Heat Recovery

Heat pump chillers can further support industrial plant efficiency and reduce operating costs through waste heat recovery. The Department of Energy estimates 20-50% of industrial energy is lost to waste heat.[3] When efficiently captured, this excess heat can become a valuable resource, enhancing efficiency and reducing operational costs. Yet only 30% of plants leverage a waste heat recovery system.[4]

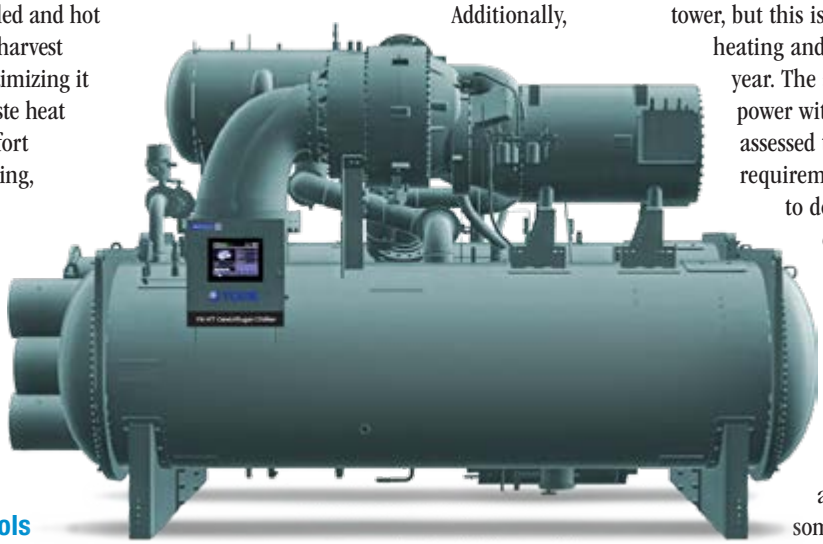
Heat pump chillers designed around two independently operating refrigerant compressors can simultaneously provide chilled and hot water. This allows the system to harvest wasted thermal energy while optimizing it for practical reuse. Captured waste heat can then be repurposed for comfort heating, water heating or reheating, which can help reduce carbon emissions and operational costs. In these applications, a heat pump chiller can be as much as five times more efficient than a traditional fuel-burning boiler and chiller combination.[5]

Taking Performance Further with Smart Controls

Digitalization is transforming both equipment performance and plant operations. Chillers with factory-installed connectivity simplify digital transformation by seamlessly integrating with intelligent building solutions. These "smart-ready" chillers eliminate the cost and complexity of manually connecting equipment using added sensors or kits. With this on-board connection, operators can remotely access data from day one of operation to optimize performance and help detect potential issues, resulting in 32% fewer unplanned service calls and greater uptime, based on Johnson Controls data.

Powered by AI and machine learning modules, intelligent solutions can unlock equipment and performance data in real-time, far exceeding what is possible with traditional building automation systems (BASs). The same technologies can then put data to work, driving up-time, enhancing efficiency, reducing costs and simplifying workflows. Using AI-driven smart building software, companies can see up to a 30% reduction in energy spend, based on Johnson Controls data. By analyzing real-time data and learning from historical trends, AI can forecast equipment degradation, notifying operators when replacements are due and help identify potential failures before they occur. If issues arise, Fault Detection and Diagnostics (FDD) allows them to be addressed in their early stages, reducing annual service costs up to 67%.[6]

These platforms can also help unburden operators by automating routine and repetitive workflows, allowing them to focus their time where it matters most. Additionally, intelligent features allow operators to simulate and plan for unpredictable conditions such as extreme weather, equipment lifecycle needs and fluctuating utility pricing. For example, a digital twin can create a realistic simulation of the plant to model and illustrate changes in equipment integration and energy costs. This information can then provide proof points to inform capital investments and long-term planning.



Centrifugal chillers designed for higher lift conditions may incorporate two compression stages or compounded refrigerant compressors to share the load and maintain efficiency.

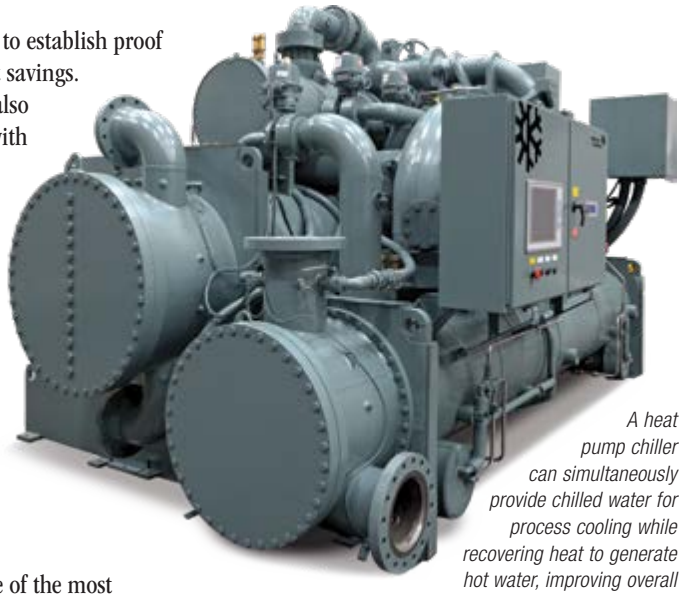
Preparing for Modern Chiller Integration

Whether a plant is expanding, adding processes to a current layout or seeking solutions to advance its efficiency goals, today's smart-ready heat pump centrifugal chillers can achieve tremendous facility enhancements.

New chillers can typically be integrated within existing plants. However, when determining equipment compatibility, it's critical to evaluate the existing piping, pump and cooling tower configuration – namely the proximity of the hot water loop to the chiller location – as well as evaluating the existing space versus the new heat pump chiller. It's also important to understand if the existing cooling towers and pumps are headed together. In this design configuration, multiple chillers may be connected to a shared hydraulic system. Because of this, it may be beneficial to add a new isolation valve when a new chiller is installed, allowing it to operate independently. In some applications, a heat pump can eliminate or reduce the need for a cooling tower, but this is dependent on simultaneous heating and cooling loads throughout the year. The amount of available electrical power within the plant must also be assessed to ensure new equipment requirements can be supported. Failing to do so can result in potential circuit overloads, voltage drops and unplanned downtime.

In many facilities, upgrading chillers can provide a practical path toward efficiency and plant optimization without requiring a complete facility overhaul. For some teams, scaling the integration of new chillers into a single process or division of the plant can

help create a pilot program to establish proof points of efficiency and cost savings. This phased approach can also provide systems engineers with an opportunity to identify any integration challenges slowing full-scale optimization. As part of this process, it's also important to consider state and local programs available for energy efficiency upgrades, as well as utility incentives to help offset costs and contribute to ROI.



A heat pump chiller can simultaneously provide chilled water for process cooling while recovering heat to generate hot water, improving overall plant energy efficiency.

Process cooling remains one of the most demanding and energy-intensive systems within heavy industry production. Yet, it also represents a significant opportunity to drive measurable progress. By holistically evaluating a plant's operating environment, industry leaders can accurately align chillers with real-world processing demands. Integrating smart-ready centrifugal heat pump chillers, VSDs and waste heat recovery technologies, cooling equipment can not only ensure consistent, reliable process cooling but also serve as a powerful catalyst to drive efficiency and reduce operating costs. BP

About the Author

Rob Tanner is the Director of Marketing for Applied Equipment at Johnson Controls. He has more than 30 years of experience in the sale, application, design, installation, service and marketing of commercial HVAC products and technologies. Before joining Johnson Controls, he was an MEP consulting engineer and co-owner of a design-build mechanical contracting company. He received his BS in Mechanical Engineering and MS in Education & Organizational Development from Pennsylvania State University.

About Johnson Controls

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Practical Free Cooling System Operation Techniques

By Clayton Penhallegon, Jr., P.E., Managing Member, Integrated Services Group

Note: This article is a companion to the Chiller & Cooling Best Practices *February 12, 2026, webinar, "Integrating Free Cooling into Chilled Water Systems." The webinar presented free cooling basics, discussed system types and potential operating hours, then looked at savings evaluations. It also discussed performance expectations and system controls. This article expands on the operation and control of the most common open tower/heat exchanger-based systems for process cooling in manufacturing and other high operating hours, high cooling load consistency applications.*

➤ Free cooling is widely recognized as a highly efficient approach to cooling without running chillers. While there are air-side and water-side economizer systems (the technical name for free cooling), process cooling requires water systems for machine heat exchangers. Free cooling can provide the same process cooling conditions in an industrial plant for roughly one-fifth the power use of chiller systems.

Free cooling is seasonally limited, however, so chillers are still required to provide year-round cooling. The savings make it a strong option in climates where it can operate for thousands of hours per year. Further, every free cooling hour is an hour the chillers don't run. This can mean significant life extension of the most expensive component in the mechanical room, with long-term savings in both chiller major rebuilds and capital replacement costs.

Above: Typical plate heat exchangers used in free cooling

Free cooling system operators face two major hurdles. The first is the transition from chiller cooling mode to free cooling, and the change back to chillers when the free cooling operation has ended. This will be covered in some detail, as it is the largest issue in many cases.

The second issue is maintaining system performance over time. While not as immediately critical as the start and stop transitions, it is vital to maximizing the free cooling investment payback. This and other maintenance aspects will also be reviewed.

Conventional Free Cooling Start and Stop Operations

In commercial applications such as office buildings and hotels, the free cooling transition is historically a stop-start process. Water-cooled chillers can struggle to maintain stable operation with the cold condenser water temperatures required for free cooling; as such, the free cooling transition has the chillers shut down (while continuing to circulate chilled water through the building), followed by the adjustment of the cooling tower setpoint to the required free cooling temperature.

The sequence of the chiller shutdown and the cooling tower water temperature drop can total as much as 10 to 15 minutes. This can cause a significant water temperature spike, but fortunately, it may go mostly unnoticed in a commercial facility. Of course, the reverse process happens when exiting free cooling, as the cooling tower water typically has to warm up before the chillers can be started. This is most commonly true with centrifugal compressor chillers, as some rotary screw compressor chillers and other positive displacement designs are more capable of starting with cold condenser water. Practically, however, the largest chillers with the most sensitive loads are centrifugal, so restarting is a significant issue in many cases.

The Importance of Free Cooling Transitions

Like many industrial processes, free cooling systems work well once they are on and running; starting and stopping are the critical times with the greatest upset potential. However, unlike general plant processes, where individual lines or departments would start or stop at any given

time, the cooling system supports the entire plant. Upsets there affect the whole operation with greater impacts from failure, especially when the rest of the plant is in full-on normal operations, as would often occur with free cooling transitions.

Consequently, the temperature spike typical in commercial settings is unacceptable in process cooling, particularly in continuous output production such as sheet and film extrusion or parts blow-molding or injection molding. While producing a block of off-spec products is bad, the worst case is the separation of a continuous web process that could require re-threading of the line and possibly even extinguishing modest fires from material drop-outs in reheat ovens.

As a result, many plants with free cooling significantly limit use to times when the transition can be made with full operator awareness and the system can operate for many days or even weeks without having to go back to the chillers. This captures some savings while minimizing the potential production impact of the transitions, but with a significant reduction in the potential benefits. Sadly, it's not uncommon to see free cooling systems out of service because they had too many upsets and plant management said, "Never again."

Streamlining Free Cooling Transitions

Given the conditions described, the critical challenge is making the transitions between chiller and free cooling modes as transparent as possible. Smooth transitions enable high operating hours and high year-round load facilities to use free cooling as many hours as possible, including many shorter periods of a day or two, or even a block of overnight hours typical in the fall and spring (i.e., the beginning and end of the free cooling season). Further, the ability to run well in these conditions makes free cooling possible in locations where there are not months of continuous cold, but there are still many hours of potential application.

The keys to acceptable transitions are two closely related items:

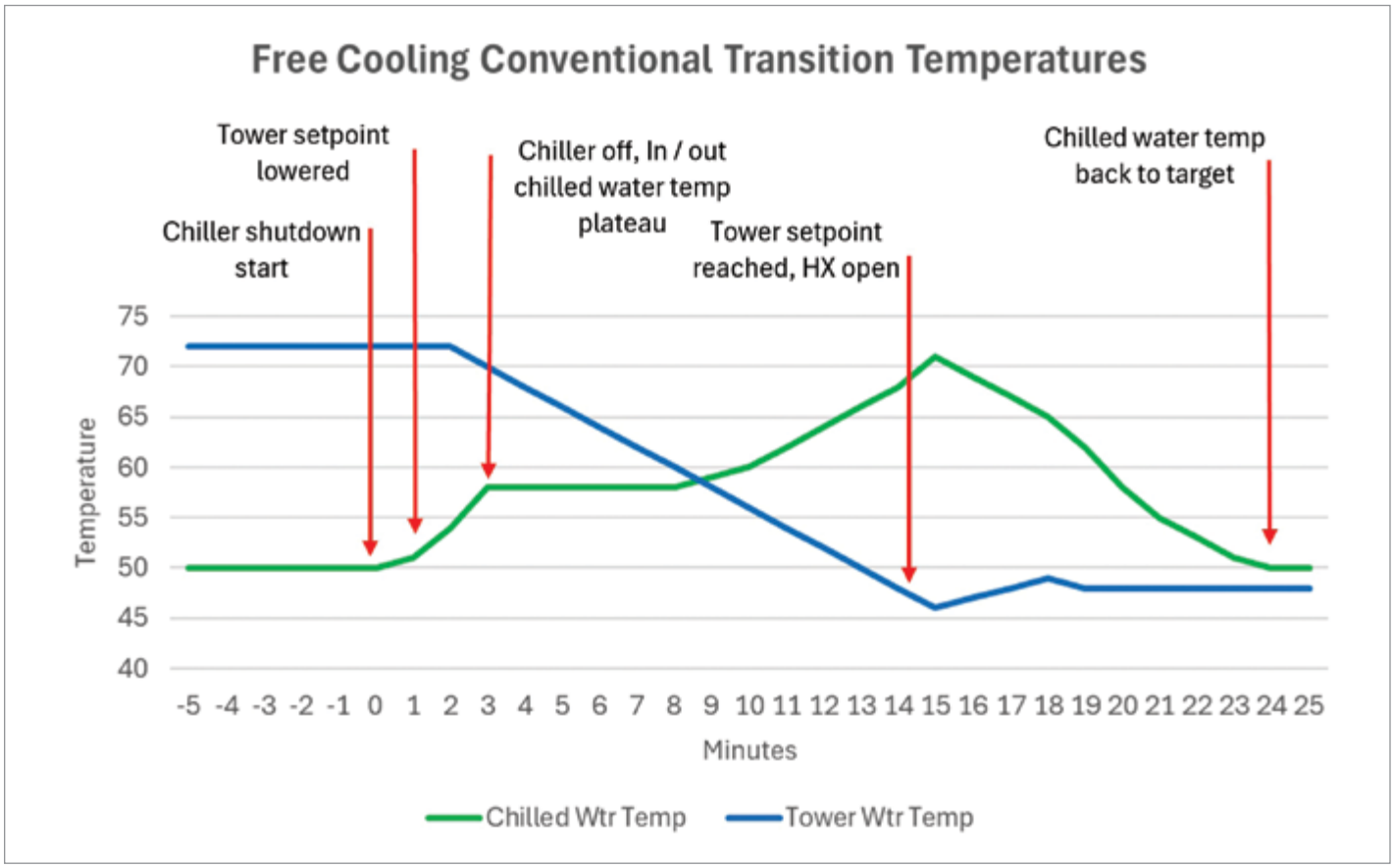
1. Improving the chiller's ability to operate longer into the transition to free cooling and start and load sooner in the transition back to chiller cooling, and
2. Minimizing the impact of starting and stopping the free cooling loop (this is not as much of an issue when going out of free cooling, but it still must be done with care).

Understanding Free Cooling Transitions

For successful free cooling start and stop operations, it is necessary to fully understand the process taking place. The starting transition consists of several steps:

1. Stopping the chiller(s)
2. Lowering the tower water temperature to that required for the heat exchanger to deliver the needed chilled water temperature (e.g., from 75°-48°F/24°-9°C)
3. Opening and purging the heat exchanger and its associated piping loops

In most conventional systems, stopping the chiller(s) is the first step. Depending on the



The temperatures and key events in a typical transition to free cooling operation

Practical Free Cooling System Operation Techniques

chiller type, it may take several minutes to unload and perform a complete shutdown.

The controls then lower the cooling tower water temperature, a 5-15 minutes process depending on (1) the initial water temperature compared to the outdoor conditions, (2) the cooling tower capacity compared to the load (less actual load compared to rated capacity results in faster drops, but plants usually have air compressors and other loads continuing when the chillers are off) and (3) the system volume of water such as tank systems or long runs of large pipe with larger total water volumes.

Opening and purging the heat exchanger is not a long part of the process, but it will add a slug of warm water to the chilled loop when fully opened promptly, as is typical with pneumatic actuated valves. In most systems, this step will add another 1-2 minute delay.

Depending on the system, these steps can result in a total uncontrolled period of 15-20 minutes or more for the total transition, with chilled water temperature rises of up to 20°F (11°C) or more, followed by a pull-down period for the chilled water temperature to stabilize at acceptable levels. If you have ever stood in a mechanical room and watched as the chilled water temperature goes up, 15 minutes is an eternity, and 20 minutes or longer is inconceivable.

Note that when this process is used in commercial applications, the time lag effect is reduced as the system loads are lower compared to peak season design capacity and there are no other cooling tower loads extending the pull-down time. It's still not ideal, but not as consequential, either.

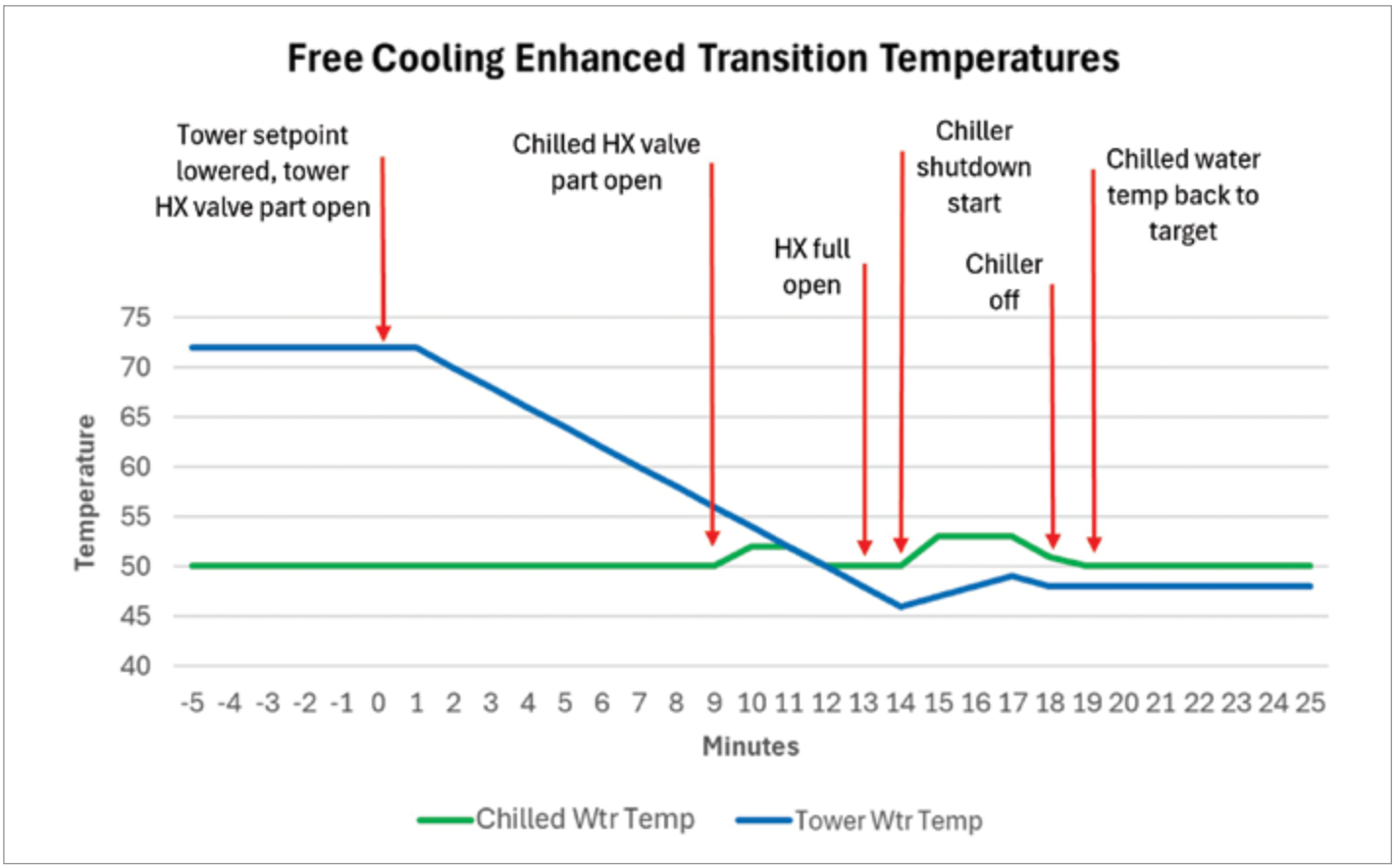
Several techniques can be employed to dramatically reduce the temperature swing and also maximize the potential free cooling operation and savings. First is enabling the chillers to run better with cold condenser water. This improves operation during the transitions. Next is better management of the heat exchanger start-up, which reduces the transitional temperature swing. The final component is defining the right conditions for entering and leaving free cooling, minimizing the risk of incomplete transitions into free cooling or fault conditions during free cooling operation, while simultaneously maximizing the run time.

Improving Chiller Stability in Free Cooling Conditions

Many chiller designs rely on the pressure difference between the evaporator and the condenser for stable compressor operation (particularly with centrifugal machines) and for oil management and other functions. VFD-equipped centrifugal chillers are more stable with cold condenser water, but even these can struggle in start-ups and with high loads and low delta Ps between the two vessels.

The condenser cooling effect is most directly controlled by reducing cooling tower water flow through several potential means:

1. Pump speed control or modulating pump discharge valves



The temperatures and key events in an improved free cooling transition

2. Chiller valve modulation to either throttle the flow or partially bypass the condenser via control from the chiller (internal to the chiller)

3. Chiller valve modulation to throttle or bypass flow through action from the cooling system controls (external to the chiller)

Flow modulation using internal chiller controls is the preferred method. This typically uses a head pressure-based control and ensures the flow control functions even if the system controls are off. In contrast, slowing the cooling tower flow at the pumps may starve other cooling tower water cooling uses, such as air compressors and machine hydraulics.

Unless there is an overriding reason, simple flow modulation to the chiller is the recommended approach. A bypass typically requires additional piping and further requires pumping at a higher rate than is otherwise needed, wasting energy. Only if a consistent total flow was needed for some reason separate from the chiller operation would it be advisable to use a bypass.

Properly implemented, chiller head pressure control can make a chiller capable of running for moderate periods with significantly colder cooling tower water than normally possible. Even so, it's still not recommended to run chillers for an extended time in parallel with free cooling for at least two reasons, one practical and one economic.

First, the butterfly valves typically used are substantially non-linear. Combined with the control function hysteresis, the condenser flow and resulting head pressure can vary more than desired for continuous operation, even if adequate for a short transition. Under various load conditions (low load, cycling), the instability could cause the chiller to fault, with the potential for insufficient plant cooling.

Second, extended cold condenser operation presumes free cooling also continues. Otherwise, it would be a standard on or off transition. In this case, the system should simply be entirely in free cooling; there is no reason to incur the energy penalty for the chiller operation. If a heat exchanger can't carry the entire plant load, the usual least cost option is to add more plates. This should be less than a two-year simple payback in most situations.

Managing the Temperature Change and Heat Exchanger Start-up

Enabling the chiller to run deeper into the free cooling transition and start sooner coming out is only the first aspect of reducing the transition impact. The complement to this is more intelligently controlling the heat exchanger flows to minimize water temperature swings. This is performed using modulating control valves on both the cooling tower and chilled water sides, which enables the cooling system controls to have different flows on the two sides through the transition.

For the cooling tower water side, the modulating valve is partially opened as the tower water temperature begins to go down. Opening the valve 20-30% provides additional cooling tower water flow and precools the heat exchanger; the chilled water temperature is unaffected, as that side remains closed. As the cooling tower water temperature drops, the tower side valve opens further until it is open ("open" may not be 100%

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open, depending on the need to provide pressure and flow to other applications).

The chilled water valve is also opened gradually, but not until the cooling tower side is nearly at the free cooling temperature, generally within a few degrees. When this trigger is reached, the chilled water valve opens partially to purge the warm water slug slowly. The still-running chiller dampens the process temperature rise, and this is assisted further by the cooling tower side pre-cooling. Once the cooling tower water reaches the target temperature, the chilled water valve opens fully, and the chillers are shut down.

There is an unavoidable bump in the chilled water temperature through this transition as uncooled evaporator water flows for several minutes during the chiller shutdown, but this is moderated by the fully operating free cooling. Multiple chillers can be shut down in sequence to further minimize the temperature impact.

When switching back to chiller cooling, the reverse process is followed, although with some adjustment of the valve open conditions depending on the chiller start-up times and temperature rise rate on the cooling tower side.

Free Cooling Start and Stop Triggers

The preceding improvements position the system for successful operation with minimal temperature variation and chiller upset risk, but the necessary adjunct is making timely decisions on when to go into and come out of free cooling. Obviously, starting the transition when the wet bulb is too high could cause an extended pull-down time (or even failure to reach the set transition temperatures) and potential issues with the chillers, even with the head pressure controls.

As outdoor conditions generally cycle each day between highs and lows, we can assume when the temperatures are trending down there will be some hours at or below the current reading. A tested strategy for entering free cooling is to delay the start until the wet bulb is below the transition setpoint for long enough to ensure it's continuous, for example, 2°F (1°C) or more below for at least 20 minutes.

Starting free cooling in these conditions should provide at least several hours of operation, although with the loss of possibly an hour or two on the theoretical start. Given the need to minimize the upset risk, this is an acceptable trade-off, especially if it allows system controls to automatically make the transitions. Despite the start time lag, this would cumulatively provide many more free cooling hours than manually switching the system only during forecast cold spells.

Switching out of free cooling is best done based on the actual chilled water temperature, with thresholds and time delays set for both load-based and equipment failure scenarios. The load-based trigger would be a smaller temperature rise for a longer time (say 2°-3°F/1°-2°C for 10 minutes) while the equipment failure (e.g., "something broke") trigger would be a higher rise for a shorter time, perhaps 8°-10°F (4°-6°C) for two minutes. These settings must be calibrated so starting a line doesn't trip the system while still providing prompt recovery if a cooling tower fan fails.

A 1600 ton free cooling heat exchanger with separate modulating control valves on cooling tower water and chilled water connections

Tuning the Transition Control

Unsurprisingly, the temperature settings and overlap times are significantly variable between systems. Small footprint systems designed for free cooling (i.e., with good cold condition cooling tower performance) may have shorter transitions due to less water volume and plenty of cooling tower effect. Larger systems and those with tanks may have longer transitions, as may conventionally selected cooling towers or cases where the cooling towers are some distance from the mechanical room.

Chiller start and stop operations are also critical. Different chiller types can have different functional step times, as well as different loading rates. It may be beneficial to choose one chiller or type as the lag chiller when going into free cooling and another for coming out. It is highly recommended to work with factory technical services to safely adjust some of the chiller default timers to make the machines more responsive for free cooling operation.

It cannot be overstated how important the careful tuning of the free cooling system and controls is to successful operation. When correctly implemented, the system can operate hundreds of hours or more than might otherwise be the case. Perhaps more critically, it may enable a system to be run at all when it may have otherwise been shut off permanently due to process disruptions.

Freeze Protection for Free Cooling Systems

Given that free cooling requires cold outdoor conditions to operate, managing systems in extremely cold weather is a common question. Different types of cooling towers (crossflow, counterflow) are prone to different freeze patterns, and the free cooling operating temperature can affect the likelihood of freezing (a 60°F/16°C system is less likely to freeze than a 42°F/6°C operation). In addition, the heat load is a major factor; a lightly loaded system is more likely to freeze.

Several approaches can be used for freeze protection. One is to simply manually switch to chiller cooling in extremely cold weather, as the warmer condenser water is less likely to freeze. Another method has the system controls switch to chiller cooling for some period (30 minutes, an hour) to thaw the cooling towers if the fans run at 60 Hz continuously while the wet bulb is sufficiently low that full fan speed shouldn't be required. Some fans can be stopped or reversed, but that normally requires a multi-cell system to keep control of the chilled water temperature.

It cannot be overstated how important the careful tuning of the free cooling system and controls is to successful operation.

As with the system tuning, the best freeze protection approach will be highly dependent on the specifics of each system and location. For system planning purposes, the key point is to be aware of the potential need and select, implement and tune the freeze protection once installed.

System Maintenance for Free Cooling Systems

Given that free cooling is virtually always an addition to an existing cooling system, incremental maintenance requirements are modest. This assumes the cooling towers and pumps are already on adequate monitoring and maintenance, chemical treatment and other supporting programs.

The primary maintenance requirement is periodic cleaning of the heat exchanger. The time between cleanings is highly dependent on the water conditions, cooling tower dirt loading (including particle nature and size), system filtration and hours of operation. The time between cleanings is learned, with observation of the temperatures and pressure drops compared to flows being key indicators.

It is highly recommended the cooling tower water, in particular, is filtered before the heat exchanger to prevent passage blockage and restricted flow. Ideally, an appropriate duplex strainer is used with basket openings less than 50% of the plate spacing; for example, a 0.1-inch plate spacing would suggest an 18 or higher strainer mesh.

Other system maintenance steps include operating the modulating and isolation valves, testing and purging pressure gauge ports (particularly on the cooling tower water, as these are prone to plugging) and checking the condition of flexible connectors and pressure tubing for physical damage or decay over time.

Conclusion

Free cooling systems are a highly efficient means of providing process cooling, however they must be operated and maintained so their operation doesn't negatively impact their host plant. The critical phase is the transition between chiller cooling and free cooling, and then back to chiller cooling. This article presented extensive information on improving the performance of these transitions. Further, free cooling systems must be maintained and protected from freezing in cold conditions. When all these pieces are in place, free cooling provides highly efficient cooling and extends the life of the chillers, a significant additional benefit of the system. BP

About the Author

Clayton Penhallegon, Jr. is Managing Member of Integrated Services Group. He has worked for over 35 years with various industries, including plastics, paper, wood products, metal containers and textiles. He holds a Bachelor of Mechanical Engineering from Georgia Tech and an MBA from Georgia State University, and is a registered PE in Georgia.

About Integrated Services Group

Integrated Services Group performs industrial cooling water system operational effectiveness and cost reduction technical services, including system assessments, new and upgrade system design, system start-up and retro-commissioning and high efficiency control design and implementation. ISG celebrated its 25th anniversary in 2022 and serves clients throughout North America. For more information, visit https://www.isg-energy.com.

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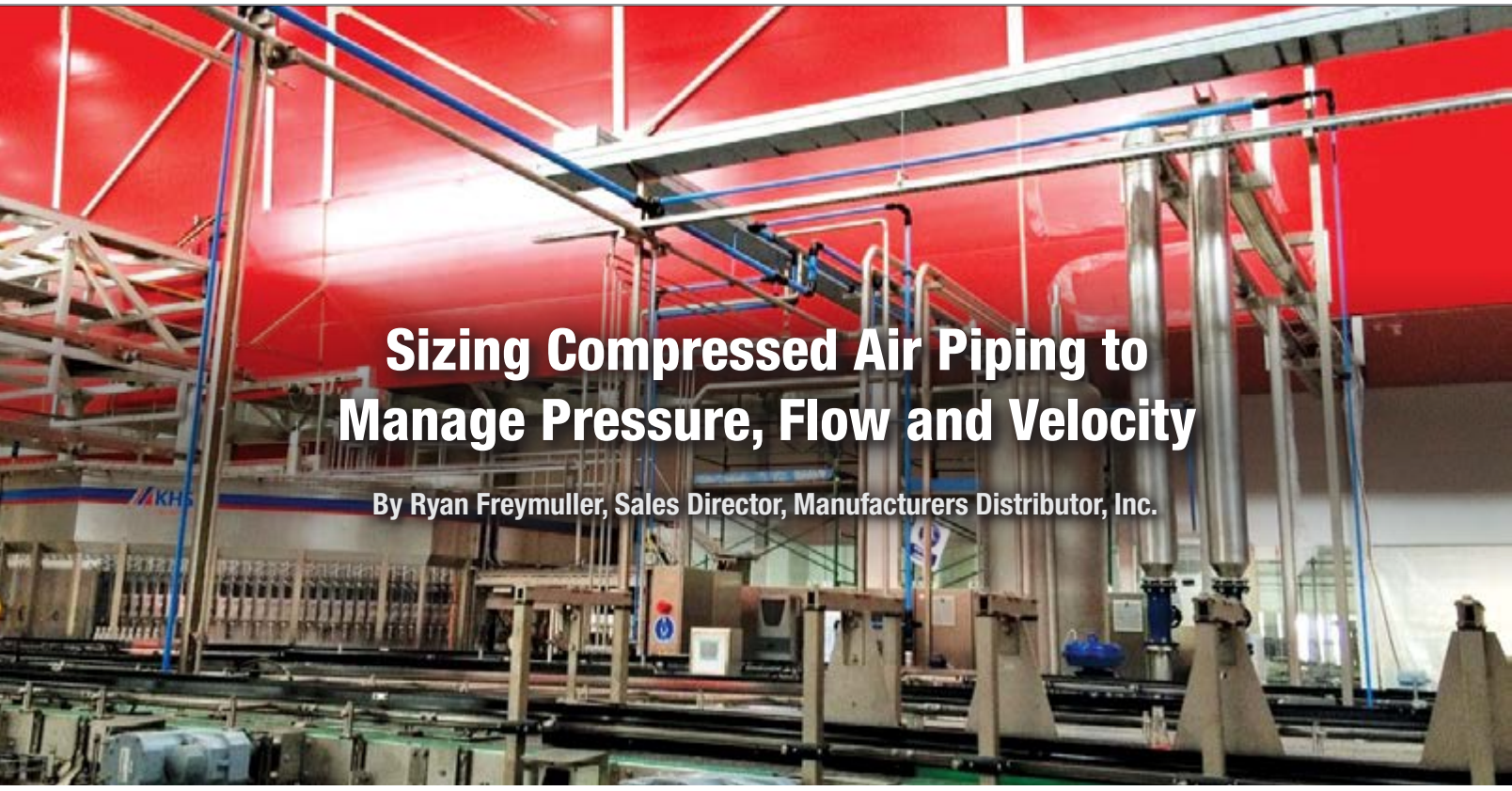

Sizing Compressed Air Piping to Manage Pressure, Flow and Velocity

By Ryan Freymuller, Sales Director, Manufacturers Distributor, Inc.

In the world of industrial infrastructure, unseen systems often have the biggest impact on efficiency, productivity and bottom-line operational costs. Among these, compressed air and gas distribution networks stand as critical lifelines in modern facilities, influencing everything from tool performance to energy consumption. At the heart of many superior compressed air systems are modular aluminum piping networks.

Modular aluminum piping systems are engineered for the distribution of compressed air, inert gases and sometimes vacuum services in plants, warehouses and manufacturing environments. Unlike traditional materials, modular systems consist of precision-extruded aluminum of grade AW-6060 T51 or AW-6063 T5 as defined in ASTM B241 and fittings that push together quickly and securely.

The lightweight nature of aluminum, combined with highly accurate manufacturing tolerances, along with smooth-bore full-flow fittings, allows these systems to deliver significant improvements in flow characteristics and minimize pressure drop compared to traditional piping technologies. Systems install quickly and operate closer to ideal pneumatic performance curves, a benefit paying dividends throughout the life of the installation.

Why Flow and Pressure Drop Matter

To understand the value modular aluminum piping provides, it helps to consider two key performance factors in compressed air and gas distribution:

Flow Efficiency. Air and gas must travel through a distribution network to reach tools, actuators and control systems. In traditional piping, rough interior surfaces and seams can disrupt laminar flow, creating turbulence and robbing the system of effective movement. Turbulent flow increases resistance, which means even with the same air compressor output, less usable flow reaches the point of use.

Modular aluminum piping tackles this by incorporating smooth, calibrated internal surfaces reducing friction and promoting laminar – or streamlined – flow throughout the system. Laminar flow reduces energy losses associated with turbulent eddies and swirling motion in the pipe, enabling more of the compressed air produced by the air compressor to be delivered where it's needed with fewer losses.

In practical terms, this improved flow can allow a facility to operate with smaller air compressor capacity or delay expensive air compressor upgrades, because the installed piping is not starving tools and machines of compressed air even at peak demand.

Pressure Drop Reduction. Pressure drop – measured in PSID (pounds per square inch differential) – represents the loss of pressure between one point in the system and another.

Because pressure drop increases with friction and turbulence, reducing either one directly improves system efficiency. Lower pressure drop means the air compressor can maintain the required pressure with less effort.

Any time a system experiences pressure drop, the air compressor must work harder to make up the loss to maintain usable pressure at the point of use. Excessive pressure drop means higher energy consumption, more frequent air compressor cycling and increased wear on equipment.

Above: A modular aluminum piping system supplies compressed air for this bottling plant. (Courtesy of Parker-Transair.)

Modular aluminum piping systems address pressure drop in several ways. Their smooth interior surfaces minimize friction that would otherwise slow flow and reduce pressure. Full-bore fittings and valves maintain a consistent flow diameter through joints, eliminating significant constrictions that can otherwise cause pressure loss. Finally, tightly sealing connectors reduces leakage – a common hidden contributor to pressure drop in threaded or welded systems.

Because pressure drop increases with friction and turbulence, reducing either one directly improves system efficiency. Lower pressure drop means the air compressor can maintain the required pressure with less effort. In many industrial settings, even a modest reduction in pressure drop can yield measurable energy savings. An industry rule of thumb estimates lowering system pressure by 2 psi results in approximately 1% energy savings.

Aerospace Manufacturer Saves on Material Costs

While flow efficiency and pressure drop improvements are central to the value proposition of modular aluminum piping, these systems also provide broader operational benefits due to their lightweight nature, making them easier to handle and fast to install.

Velocity concerns can be mitigated by proper system design. Using a loop system can help maintain reasonable velocity. Leak reductions will also help prevent artificial velocity increases. A piping product with a leak-free guarantee is paramount. Another important factor is having a trained installer who knows how modular systems connect differently from traditional piping systems.

Recently, a major aerospace manufacturer in Texas was setting up its new plant with a 4-inch main line specification based on its engineers' piping specifications. After evaluating the flow rate, pressure drop and velocity, mdi was able to help this client maintain the same performance using a 2 ½-inch main line in a loop configuration in lieu of a U-shaped compressed air piping system. This reduced its material cost by over 40% and reduced its installation time by 25%. Additionally, we were able to train this client to have its own personnel certified to install its systems, making them totally self-sufficient.

This client now uses modular aluminum piping systems in all its facilities.

Because modular aluminum piping is assembled from interchangeable components, adding new branch lines, relocating service drops and expanding the system to new parts of a facility is easier than with rigid welded piping. No welding, threading or heavy fabrication is required, which reduces installation costs and downtime. Adaptability matters in modern manufacturing environments where retooling and layout changes are frequent.

Aluminum does not rust or corrode like steel, a property preserving internal surface integrity and preventing debris and scale buildup. A clean, corrosion-free pipe interior also benefits filters and compressed air dryers downstream of the main header, making routine system maintenance more effective.

The maintenance shop for this light rail line is powered by compressed air delivered through modular aluminum piping. (Courtesy of Parker-Transair.)

Conclusion

In industrial compressed air and gas systems, efficiency isn't just about producing the required pressure; it's about delivering usable flow with minimal loss and reasonable velocity as compressed air travels through the distribution network. By minimizing friction, reducing pressure drop and enabling future system adaptability, modular piping systems help facilities operate efficiently, save energy and maintain reliable service to tools and equipment. When combined with expert guidance and strong logistics support, businesses gain not just piping, valves and fittings, but also a performance-oriented distribution partner.

For industrial facilities relying on compressed air to power production, choosing the right piping system is no longer a background decision; it's a strategic choice influencing energy costs, uptime and long-term facility flexibility. BP

About the Author

Ryan Freymuller serves as the Sales Director for Manufacturers Distributor, Inc. (mdi), a national supplier of Transair Aluminum Pipe and industrial equipment based in Odessa, FL. In this role, he uses his 30 years of industrial experience to oversee sales initiatives, logistics and technical product training for the company, which has been recognized as one of the fastest-growing private companies in the United States.

About Manufacturers Distributor, Inc.

Since its founding in 2002, Manufacturers Distributor, Inc. has grown into a respected distributor of industrial equipment and systems, serving a wide range of industries dependent on fluid flow technologies. The company's expertise in modular aluminum piping systems helps facilities optimize flow, reduce pressure loss, get the correct compressed air velocity for their applications and operate more efficiently, resulting in energy savings and more consistent performance in critical industrial processes.

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BETTER PLANTS INSIGHTS

Better Plants Program Offers Free Virtual Training

By Alex Botts, Research Associate, Oak Ridge National Laboratory

In compressed air systems, knowledge gaps often translate directly into wasted energy, higher operating costs and reduced system reliability. In past columns, you've read about my travel from site to site delivering training at manufacturing partner facilities tailored to each host site. We also host Energy Bootcamps twice a year at Oak Ridge National Laboratory in Knoxville, TN, offering a crash course in energy efficiency.

The Better Plants Program's Virtual Trainings offer targeted industrial efficiency training for people who can't travel for in-person learning.

But as with every resource developed for this program, our partners needed something different. Not all partners can travel for training due to time or budget constraints, and not all facilities can host their own training. Students or assessors may not work at manufacturing sites at all. To help close this workforce development gap, the Better Plants Program developed Virtual Trainings.

Virtual Trainings (VTs) are online versions of our popular In-Plant trainings. Like their in-person counterparts, VTs help attendees understand their systems, identify energy efficiency opportunities, quantify potential improvements and create an action plan to realize the results, all in a virtual format.

How Virtual Trainings Work

When introducing the trainings, I often describe them as being similar to a college course. Classes meet once a week for roughly two hours and run between four and eight weeks, depending on the topic. At the end of each session, participants are given homework. Rather than assigning theoretical problems or case studies, the homework focuses on each participant's own facility. For example, one assignment may ask participants to construct a compressed air block diagram for their site. At the beginning of the next class, homework is reviewed. Trainings also include quizzes to reinforce key concepts. I remind partners, "You'll get out of a training what you put in;" in other words, do the homework. National experts lead many sessions, providing world-class instruction at no cost.

Because these trainings are designed to meet partners where they are, we recognize not everyone can attend every live session. That's why all classes are recorded. It's okay if participants miss a session or even a whole topic. Recordings from the last two years are available, along with supporting materials.

Since launching in November 2020, the program has trained over 2,000 participants through live classes, with many accessing the recordings afterward. To no surprise, the compressed air course remains the most popular.

How to Access Virtual Trainings

Classes are open to anyone and available at https://bptraining.ornl.gov. In 2026, the program offers seven live classes, as seen in this table. Video recordings of completed classes are available. Whether participants are new to industrial systems or looking to deepen their technical expertise, these trainings are designed to turn knowledge into measurable savings at any facility. BP

Topic	Dates
Compressed Air	8 sessions (January-March)
50001 Ready	8 sessions (February-April)
Industrial Water Efficiency	8 sessions (June-August)
Process Cooling	8 sessions (July-September)
Making a Business Case	6 sessions (June-July)
Steam Systems	8 sessions (October-December)
Combined Heat and Power Systems	4 sessions (December)

About the Author

Alex Botts, CEM, is a Research Associate at Oak Ridge National Laboratory, serving as a Technical Account Manager for the DOE's Better Plants Program. She supports industry partners with data analysis, Energy Treasure Hunts and software, guiding them to achieve energy savings and developing training programs.

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SALES ENGINEERING SKILLS

What Top-Producing Sales Engineers Have Learned to Do

By Mark Allen Roberts, CEO, OTB Solutions

Making sales in the compressed air industry is a discipline. Over the past two decades, we've learned a great deal about what separates top-producing industrial sales engineers from everyone else. We know the daily behaviors driving revenue. We understand the mindset patterns sustaining performance. And we also know a hard truth: Fewer than 15% of sales engineers consistently perform at top levels.

The difference isn't technical knowledge. Most compressed air sales engineers are highly competent in applications, system design and troubleshooting. The difference is behavioral discipline: Top performers execute critical sales behaviors even when they're uncomfortable. Others wait until they feel ready, confident or certain. That gap is what I call the action-emotion paradox.

The Action-Emotion Paradox in Industrial Sales

Most sales engineers believe they need confidence before they act. They want to feel prepared before making the prospecting call. They want to feel certain before asking for the order. They want more information before challenging a buyer's assumptions. However, emotion frequently follows behavior, not the other way around.

Mark Allen Roberts will lead a Sales Engineering Workshop at the Best Practices 2026 EXPO & Conference in Indianapolis, IN.

This paradox shows up in familiar ways: You don't feel like making a cold call to a new plant engineer. You hesitate to push for clarity on a budget or timeline. You avoid challenging a customer who is undersizing a compressed air system. These delays might feel small, but they quietly erode your pipeline, credibility and results.

Sales engineering is emotionally exposed work. You risk rejection. You risk objections. You risk being told your price is too high or the existing supplier is good enough. Neuroscience tells us social rejection activates similar brain pathways as physical pain. Your brain naturally nudges you toward comfort behaviors.

So instead of prospecting, you check email. But understand avoidance increases anxiety, anxiety lowers confidence and lower confidence hurts performance. Top producers understand the motivation they're waiting for is often on the other side of the action they're avoiding.

In Industrial Sales, Movement Creates Momentum

Momentum in sales doesn't start with emotion; it starts with movement. It could be one proactive call or one firm follow-up. A small action leads to a small win, which leads to increased belief and more action.

Instead of hoping the customer will get back to you, try collaborative but direct language. Say, "We discussed installing the new air compressor before peak season to avoid downtime. Our lead time is four weeks. Can we secure the order this week, so we stay on schedule?"

That isn't aggressive. It's responsible. Your customers depend on compressed air reliability. Helping them decide is part of your job.

If you wait until you feel confident, ready or perfectly informed, you'll lose to someone willing to act sooner. Top producers share three traits: They prospect before they feel ready, they follow up before it feels comfortable and they ask for the order before it feels certain.

What is the one sales behavior you've been avoiding? Do it today, and you'll thank me later. BP

About the Author

Mark Allen Roberts is the CEO of OTB Solutions, which provides professional training and coaching. Visit https://www.nosmokeandmirrors.com.

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Real-World Installations & Maintenance

Edited by Troy Dreier, Senior Editor, Compressed Air Best Practices® Magazine

There's much we can learn from real-world compressed air, blower, vacuum, chiller and cooling tower installations. This column asks readers to share lessons learned from system installations and maintenance practices they encounter in the real world.

Repairing Cold Weather Damage at a Recycling Plant

Cody Heckler is a Field Service Manager for National Compressor Services, which specializes in servicing and repairing reciprocating, rotary and centrifugal air compressors for industrial manufacturing clients. Its headquarters is in Houston, TX, with multiple locations across the U.S. Visit https://national-compressor.com.

A scrap metal and rubber recycling plant outside South Bend, IN, experienced a problem with its long-running rotary screw air compressor thanks to a cold snap this winter. Freezing temperatures caused a weld break on the oil side of the air compressor's aftercooler. The air compressor sits next to the plant's rubber shredding machine, and overflow occasionally gets sucked into the air compressor. When Heckler removed the damaged aftercooler, he found eight inches of shredded rubber between the aftercooler and the cooling fan's frame.

Improved ventilation and an enclosed air compressor room with ambient temperature controls would have prevented this air compressor from being damaged by cold temperatures.

Submission Guidelines

We invite subscribers to share stories and photos of remarkable system installations they've come across. Email Troy Dreier at troy@airbestpractices.com. Please send a high-resolution image as a JPG or GIF file and a note describing the installation.

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