

COMPRESSED AIR | CHILLER & COOLING BEST PRACTICES

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The Standards Issue

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BEST PRACTICES

2026 EXPO OCTOBER 13-15 INDIANAPOLIS, IN
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AGENDA AT A GLANCE

TRACK 1: SYSTEM DESIGN & OPTIMIZATION | TRACK 2: MAINTENANCE, RELIABILITY & PERFORMANCE

*All sessions are subject to change

TUESDAY, OCT. 13, 2026

SESSION #1: 8:00AM-9:15AM

TRACK 1: NATURAL REFRIGERANTS AND HEAT PUMP ENERGY SAVINGS

Mustafa Wahid, Roche Diagnostics; Rob Tanner, Johnson Controls

SESSION #2: 9:30AM-11:00AM

TRACK 1: OPTIMIZING CHILLER PLANTS AND FREE COOLING SYSTEMS

Hemant Tiwari, St. Jude Children's Research Hospital; Jim Nonnenmann, PRVN Consultants

SESSIONS #1 & #2: 8:00AM-10:30AM

TRACK 2: CAGI EDUCATION SEMINAR – COMPRESSED AIR EFFICIENCY, AUDITING PRACTICES AND CERTIFICATION

Neil Mehltrittter, Kaeser Compressors; Justin Russell, Ingersoll Rand; Mark Krisa, Ingersoll Rand; Chad Larrabee, Compressed Air & Gas Institute



11:15AM-12:15PM | OPEN TO ALL ATTENDEES

OPENING DAY PANEL DISCUSSION: The Critical Importance of Industrial Energy & Water Efficiency

Moderated by Andrew Berger, President, Indiana Manufacturers Association; Roderick Smith, Compressed Air Best Practices.
Panelists: Mustafa Wahid, Roche Diagnostics; Brad Runda, Runda Energy Consulting; Jim Nonnenmann, PRVN Consultants; Jose Luis Sarmiento Escalante, John Deere



WEDNESDAY, OCT. 14, 2026

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7:30AM-9:00AM

WOMEN IN COMPRESSED AIR, VACUUM & COOLING NETWORKING BREAKFAST From Exception to Expectation: How Women Are Rewriting What Leadership Looks Like

Keynote Speaker: Laura Lemons, Director, Administrative Services Center, Eli Lilly and Company



SESSION #3: 8:00AM-9:15AM

TRACK 1: INTEGRATED ENERGY EFFICIENCY AND DECARBONIZATION CASE STUDY

John Troyer, Schneider Electric; Edward Kiser, PE, World Energy Innovations

TRACK 2: WRITING FOOD INDUSTRY SUPPLY CHAIN COMPRESSED AIR QUALITY SPECS & COMPLIANCE GUIDELINES

Roderick Smith, Compressed Air Best Practices; Phil Kruger, Harris Equipment

SESSION #4: 9:30AM-11:00AM

TRACK 1: INTERMITTENT DEMAND CONTROL STRATEGIES: FROM MULTIPLE VSD COMPRESSORS TO SOLUTIONS FOR BIG AIR EVENTS

Tim Dugan, Compression Engineering Corporation; Tom Taranto, Data Power Services

TRACK 2: SUSTAINED ENERGY REDUCTION THROUGH OPERATIONAL DISCIPLINE AND ENERGY MANAGEMENT

Jose Luis Sarmiento Escalante, John Deere; Brad Runda, Runda Energy Consulting

11:15AM-12:15PM | OPEN TO ALL ATTENDEES

PLENARY SESSION: The Future of Manufacturing

Jake Hall, the Manufacturing Millennial, explores workforce pressures, rising production demands, energy challenges and the need to optimize core plant utilities.



OCT. 13 OR OCT. 14: 2:00PM-3:30PM

CERTIFIED COMPRESSED AIR SYSTEM SPECIALIST EXAM



View the full conference agenda at CABPEXPO.COM/AGENDA



SESSION #5 : 8:00AM-10:00AM**TRACK 1: DESIGNING HIGH-PERFORMANCE COMPRESSED AIR SYSTEMS**

Bryan Jensen, Independent; Peter Vinck, Inflow Corp; Gil Rangel, ADG Concepts

TRACK 2: REAL-WORLD COMPRESSED AIR RELIABILITY AND MAINTENANCE LESSONS

Sal Calvo, Compressed Air USA; William Orndorff, Kiriu USA; Mustafa Uslu, Revindus

SESSION #6 : 10:15AM-12:00PM**TRACK 1: UTILITY INCENTIVES, M&V & DEMAND-SIDE OPTIMIZATION**

Billy Alston, TRC; Karthik Radhakrishnan, Energy Sciences; Nasr Alkadi, CLEAResult

TRACK 2: COOLING CHALLENGES AND PRACTICAL SOLUTIONS IN PLANT OPERATIONS

Clayton Penhalegon, Integrated Services Group; Tom Thompson, Efficient Plastics Solutions; Richard Francis, CM Towers

Conference Workshops**Compressed Air Challenge**

Learn how to achieve 10-30% cost savings through more effective production and use of compressed air. Participants must attend all sessions.

OCT. 13, 1:00PM-4:00PM |

OCT. 14, 8:00AM-11AM AND 2:00PM-4:00PM

**Compressed Air Treasure Hunt**

Go beyond your annual leak audit with five demand side Treasure Hunt projects that reduce flow and pressure to uncover energy savings. Includes hands on work with fully operational table top compressed air labs and pneumatic circuits.

OCT. 13, 8:00AM-11:00AM

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**Pneumatic Conveying**

Strengthen your skills in pneumatic conveying system design and troubleshooting. Complete live sizing exercises, review case studies and participate in a group mock system design activity.

OCT. 13, 8:00AM-11:00AM

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**Industrial Chilled Water**

Advanced training on the design, operation and optimization of process chillers and industrial chilled water systems.

OCT. 14, 8:00AM-11:00AM

Sales Engineering

Sales Foundations – Introduces the core skills needed to confidently engage prospects and guide conversations that lead to revenue. Two identical sessions offered.

OCT. 13, 8:00AM-11:00AM |

OCT. 15, 8:00AM-11:00AM

Precision Prospecting – A fast-paced, practical session focused on building a reliable prospecting system.

OCT. 14, 9:30AM-11:00AM

EXPO FLOOR HOURS

Tuesday, October 13 12:00PM-6:00PM
Wednesday, October 14 12:00PM-5:00PM

**Leak Detection Pavilion**

Locate compressed air leaks, demo ultrasonic leak detector technology, learn best practices for planning and conducting leak assessments and discover how to use leak quantification and cost analysis tools to estimate potential energy savings.



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OCT. 13, 12:00PM-5:00PM |
OCT. 14, 12:00PM-3:30PM

New Technology Pavilion

Explore new technologies from leading manufacturers of compressed air, filtration, monitoring and pneumatic components.

OCT. 13, 1:00PM-5:00PM | OCT. 14, 1:00PM-4:00PM

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**Networking Event at Punch Bowl Social**

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OCT. 13, 6:30PM-9:00PM

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Early Bird Rates End 9/30



COMPRESSED AIR SYSTEM FEATURES

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» FROM THE PUBLISHER



Find Your Next "Best Practice" at the Best Practices 2026 EXPO & Conference

A chance moment of inspiration could change your career or the future of your firm.

We invite our subscribers to network together at the Best Practices 2026 EXPO & Conference, taking place October 13-15, 2026, at the Indianapolis Convention Center. Did you know Indy is a direct flight away from most U.S. cities, and its state motto is "Crossroads of America"? Did you know Indiana leads the country in manufacturing's percentage of state GDP at 27%? Manufacturing matters to Indiana.

Turn back to pages 4 and 5 to see a mini-program listing the highlights of the EXPO & Conference. You'll find presentations on dilute- and dense-phase pneumatic conveying, low-GWP chillers, natural refrigerants, adiabatic/hybrid heat rejection, high-pressure compressed air applications, vacuum centralization, boosters, treasure hunts for demand reduction, compressed air quality specifications, multiple VSD air compressor automation, energy management, sales prospecting and sales closing strategies.

I'm excited about our new-format Opening and Plenary Sessions this year! The Opening Session is a panel discussion on "The Critical Importance of Industrial Energy & Water Efficiency." It will be led by Indiana Manufacturers Association President Andrew Berger with expert panel members Mustafa Wahid (Roche Diagnostics), James Nonnenmann (PRVN Consultants) and Brad Runda (Runda Energy Consulting Services) and Jose Luis Sarmiento Escalante (John Deere).

The Plenary Session on day two features a well-known robotics and automation expert, Jake Hall, also called "The Manufacturing Millennial." I'm sure we'll hear an entertaining and dynamic presentation about robotic dogs able to perform compressed air leak surveys, the future growth of industrial automation and appropriate workforce development strategies.

Visit <https://cabpexpo.com/> for more information. We look forward to seeing you in Indianapolis. If you're bringing a group, please contact Kimberly Hill at kimberly@airbestpractices.com for a discounted group rate.

As always, thank you for investing time and resources in **Compressed Air & Cooling Best Practices**.

RODERICK M. SMITH, Publisher, rod@airbestpractices.com

*Source: U.S. Bureau of Economic Analysis. NAICS Codes 31-33, 2025 data



Jose Luis Sarmiento Escalante
John Deere



Andrew Berger
Indiana Manufacturers Association



Mustafa Wahid
Roche Diagnostics



James Nonnenmann
PRVN Consultants



Brad Runda
Runda Energy Consulting Services



Jake Hall
The Manufacturing Millennial

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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!



← Our Publisher had the pleasure of visiting Norm Blanchard and Greg Savage (left to right), who are part of the Energy and Utilities team at Purdue University in West Lafayette, IN. The two are pictured at the university's Northwest Chiller Plant, where free-cooling has generated significant energy savings on their duplex centrifugal chiller plant totaling 11,700 tons. Visit <https://www.purdue.edu>.

→ Subscriber Brian Larson is Vice President of Great Lakes Air, which is known for its compressed air treatment products, including refrigerated and desiccant compressed air dryers and compressed air filtration, as well as nitrogen generators. Based in Southeast Michigan, the company launched in 1983 with a commitment to "Total Quality Management," offering a five-year warranty on its entire line of refrigerated compressed air dryers. Visit <https://glair.com>.



← Based in Waukesha, WI, Liberty Systems provides on-site nitrogen generators, filtration and air dehydration equipment for industrial and food manufacturing applications. It takes a customer-focused approach, aiming to go beyond technology and deliver custom solutions. With ISO 9001:2015 certification, it demonstrates a commitment to quality management and meticulous documentation. Shown here is Sales and Marketing Manager Lukas Jaglowski. Visit <https://lsn2.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.



At the Best Practices 2025 EXPO & Conference, Tim Wasmer, Founder and CEO, The Wasmer Company, was pleased to show off our feature on his company's work with Kirsh Foundry, helping it optimize its compressed air and nitrogen generation systems. Wasmer delivered a presentation on the work later in the conference. His company works in industrial energy optimization, helping manufacturers reduce energy consumption and advance sustainability goals. Visit <https://wasmerco.com>.



A repeat attendee at the Best Practices EXPO & Conference, Caleb Powell knows the best way to enjoy the show is to bring the family and make a vacation out of it. Powell is the Industry Outreach Coordinator for the Tennessee Department of Environment & Conservation. He posed with his wife, Shelby, and children at the 2025 show's free networking event. "Each year, the conference gives me a chance to dive into new ideas, whether through the educational sessions or simply walking the expo hall and seeing what's emerging in the industry," he said. Visit <https://www.tn.gov/environment.html> and <https://cabpexpo.com>.

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NEWS Compressed Air Industry & Technology

BAUER Introduces the BLP 3 Series of Rotary Screw Air Compressors, Expanding into the Low-pressure Market

BAUER COMPRESSORS has entered the low-pressure market with the launch of the BLP™ 3 series of rotary screw air compressors. This series delivers dependable compressed air for industrial, commercial and utility applications where consistent performance and long service life matter most. Units offer discharge pressures of 125-175 psig (9-12 bar) and max flow performance of 47-93 scfm.

Engineered with precision components and robust construction, this series was designed for continuous operation in harsh industrial environments and to provide an expected service life of 20-25 years with proper maintenance, resulting in one of the lowest total costs of ownership in its class.

The BLP 3 series features a complete package design including a heavy-duty base skid, sound-attenuated enclosure, stainless steel tubing,

combination air/oil cooler and BAUER's intuitive B-CONTROL™ system. Optional tank and dryer modules can be seamlessly integrated to create a turnkey compressed air solution tailored to customer requirements. The optional tank module incorporates a rugged powder-coated steel receiver with integrated lifting and transport provisions, allowing the entire system to be safely moved with a pallet jack or forklift.



BAUER's BLP™ 3 rotary screw air compressor

Every unit comes standard with BAUER CONNECT® IoT, providing secure 5G-enabled remote monitoring and real-time visibility into critical operating parameters, including system status, run hours, maintenance schedules, pressures, temperatures and filter condition. Historical operating data is stored for up to five years, while alarms and system notifications

can be instantly delivered via push notifications, helping operators maximize uptime and proactively plan maintenance activities.

For applications requiring continuous air quality verification, the optional BAUER B-DETECTION™ monitoring system provides real-time measurement of critical air quality parameters, including moisture content and volatile organic compounds. Fully integrated with both the B-CONTROL and BAUER CONNECT platforms, B-DETECTION can automatically alert operators, distributors and BAUER personnel whenever air quality parameters fall outside specified limits and can even stop air compressor operation to protect downstream equipment and processes.

Backing the BLP 3 series is the company's industry-leading support network and comprehensive warranty program, including a five-year, bumper-to-bumper warranty and 10-year air-end warranty. For more information, visit <https://www.bauercomp.com>.

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KSI Technologies Acquires Drymec, Strengthening Its International Position

KSI announced its U.K. subsidiary, KSI Technologies, has acquired 100% of Drymec. The acquisition further strengthens the company's international position in compressed air treatment and highlights its continued growth and expanding presence across key regions, including Europe, North America, Asia and India.

KSI Technologies has a strong U.K. manufacturing base, producing desiccant compressed air dryers, line filter elements, filter housings and condensate management products. Drymec has been a trusted partner of the company for more than 15 years, making the acquisition a natural strategic step and a solid foundation for future growth.

"This acquisition is a logical next step for KSI," said Mark Terry, Managing Director, KSI Technologies. "KSI Technologies and Drymec have worked closely together for many years. By bringing Drymec into the KSI group, we are strengthening our combined capabilities while ensuring continuity for customers and partners."

For more information, visit <https://ksi-technologies.com>.

Hitachi Global Air Power Highlights Regional Manufacturing Strength

Hitachi Global Air Power US hosted U.S. Representative Frank J. Mrvan (IN-01) at its facility in Michigan City, IN, for a tour focused on advanced manufacturing, workforce development and community investment. He was joined by Michigan City Mayor Angie Nelson Deutch and representatives from the Michigan City Chamber of Commerce.

The company has made significant upgrades to its Michigan City operations in recent years, enhancing production capabilities while prioritizing energy efficiency and sustainable practices. These include a \$30 million capital

investment in the construction of an 80,000 square-foot fabrication shop, a canopied storage building, an additional parking lot for employees and optimization of the previous footprint.

The company's presence in Michigan City has long contributed to the region's economic vitality, supporting hundreds of jobs and fostering workforce development through partnerships with local training institutions and agencies. In addition to its manufacturing footprint, Hitachi Global Air Power is actively engaged in community initiatives, including a recent mural donation and environmental stewardship efforts on its campus and within the larger community.

"Thank you to all of the leaders and employees with Hitachi Global Air Power for the opportunity to see firsthand the latest investments and innovations at your facility in Michigan City," said Rep. Mrvan. "I am grateful for your dedication and commitment to the strength of Northwest Indiana's economy, our workforce and our exemplary manufacturing capabilities."

"Hitachi Global Air Power has been an important part of Michigan City's story for generations, and we are proud to see the company continuing to invest in its people, its facilities and our community," Mayor Nelson Deutch said. "These investments strengthen our local economy, create opportunities for our workforce and reinforce Michigan City's reputation as a place where advanced manufacturing continues to thrive." For more information, visit <https://www.hitachiglobalairpower.com>.



Economic Development Corporation of Michigan City Executive Director Clarence Hulse, Michigan City Mayor Angie Nelson Deutch, Hitachi Global Air Power CEO Hideki Fujimoto, Rep. Frank Mrvan (IN-01), Michigan City Chamber of Commerce President Kurt Gillins and Michigan City Director of Redevelopment Skyler York (left to right)

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NEWS Compressed Air Industry & Technology

Manufacturing Millennial Jake Hall to Keynote Plenary Session at Best Practices 2026 EXPO & Conference

Jake Hall, known as the Manufacturing Millennial, will keynote the Plenary Session of the Best Practices 2026 EXPO & Conference in Indianapolis. His presentation, "The Future of Manufacturing," takes place Wednesday, Oct. 14, from 11:15 a.m. to 12:15 p.m. and is open to all attendees.

Hall is an advocate for manufacturing, automation and skilled trades. With an audience of 120,000 followers and over 250 million views on his content, he drives discussions on manufacturing and automation to help engage both current and future workers.



Jake Hall, the Manufacturing Millennial

In "The Future of Manufacturing," Hall will address the workforce and operational pressures facing manufacturers, including retirements, production demands, energy challenges and the need to optimize core plant utilities such as compressed air and chilled water. He will outline how companies can adopt new technologies – AI, digitization, automation and robotics – to strengthen reliability and engage the next generation of workers entering the industry. Key takeaways include:

- Leveraging emerging technologies to support production and reliability
- Applying automation, digital tools, frontline worker solutions and AI
- Engaging and retaining younger generations in manufacturing

Hall started his manufacturing career at the age of 15, working for a custom machine builder sweeping floors, cleaning CNC machines and learning to weld. He later earned a degree in Product Design and Manufacturing Engineering from Grand Valley State University. Hall spent the next 10 years working in automation distribution and systems integration around robotics, machine vision, motion control, digital software and smart manufacturing. He launched the Manufacturing Millennial in 2023 and now delivers keynotes at events around the world advocating for manufacturing. To register, visit <https://cabpexpo.com/registration-2026>.

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Atlas Copco Compressors USA Announces U.S. Assembly of G Series Air Compressors

Atlas Copco Compressors USA announced the expansion of its G series 90-250 horsepower (hp), oil-injected, rotary screw air compressors assembly to Bay Minette, AL. This transition marks an important milestone in the company's ongoing efforts to enhance service, improve supply chain performance and support customers across the United States and regional markets.

The Bay Minette facility is strategically positioned to support key industrial markets throughout the United States and will serve as a central assembly location for the G series product line. By assembling air compressors closer to the customers and industries they serve, Atlas Copco Compressors USA can improve delivery timelines and increase operational flexibility.

"Assembling our G series air compressors in the United States allows us to work more closely with customers, respond more quickly to changing requirements and simplify product customization," said Philippe Ernens, President Business Area Compressor Group, Atlas Copco Compressors. For more information, visit <https://www.atlascopco.com>.

FNA COMPRESSORS Appoints Terry Gobble as President, North America

FNA COMPRESSORS appointed Terry Gobble President of its U.S. subsidiary headquartered in Fort Mill, SC. Gobble previously served as Vice President of Sales, Marketing and Product Development. In his new role, he oversees all aspects of FNA's compressed air business operations in the U.S. and Canada.

"I'm fortunate to build upon strategies set by our global leadership to ensure the history and reputation of FNA in the air compressor space are replicated and recognized across North America," said Gobble, acknowledging FNA Founder and CEO Roberto Balma and Global General Manager Corrado Tomatis. "The industry is changing, and FNA Compressors is well equipped to serve the compressor distribution network in the U.S."

The company's NUAIR rotary screw air compressors range from 3 to 100 horsepower (hp) with belt-, direct- and inverter-driven models across its Orion, Mercury, Sirius and Polar Series offerings. NUAIR heavy-duty reciprocating air compressors range from 2 to 20 hp in tank-mounted, single-stage, two-stage and duplex configurations.

FNA recently completed an office and showroom renovation at its 104,000-square-foot headquarters in Fort Mill. The company's sales organization is led by Jeremy Tarr, with Nicola Ceccon and Christopher Barfield supporting the industrial division.

"As a global, family-run company, our U.S. team is able to leverage direct communication with global leadership and technical offices to deliver support quickly and exceed customer service standards," said Gobble. For more information, visit <https://www.fnacompressors.com>.



Terry Gobble, President, FNA COMPRESSORS

Donaldson Expands Connected Technology Solution Offering

Connected Technology will provide additional Donaldson Company announced the expansion of iCue™ Connected Technology into its portfolio of filtration equipment for industrial gases and hydraulic fluids.



iCue™ Connected Technology's real-time performance monitoring helps drive operational efficiency.

The iCue technology, already widely available on Donaldson Smart Collectors, is a monitoring system that gathers and analyzes data from industrial filtration equipment to help drive efficiency. A collection of sensors tracks performance indicators to provide operators with real-time insights to help support uptime, manage maintenance intervals and extend equipment life.

Available on the Ultradryer+ series of heat-regenerated adsorption dryers, the iCue Connected Technology will provide additional equipment status visibility to organizations relying on clean and dry compressed air and gases.

At the same time, the technology is also being integrated into Donaldson Hy-Pro™ Vac-U-Dry (VUD) vacuum dehydrators. Designed for the removal of water and particulates from hydraulic and high-viscosity lubricating oils, the VUD plays a critical role in optimizing equipment performance.

"Both systems use an array of standard and optional sensors that deliver performance metrics specific to the equipment and application," said Bart Robbeets, General Manager of Industrial Gases, Donaldson.

Organizations in demanding environments can set operational parameters and alerts to monitor performance from any connected device. The dashboard provides 24/7 visibility and can be used to help initiate on-site service depending on regional availability. For more information, visit <https://www.donaldson.com>.

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NEWS Chiller & Cooling Industry & Technology

EVAPCO Celebrates 50 Years of Evaporative Cooling and Heat Transfer Innovation for Global Markets

EVAPCO celebrated its 50th anniversary, marking five decades of innovation, customer partnerships and global growth. Founded in 1976 by Wilson E. Bradley and William E. Kahlert, the company began as a small, refrigeration-focused business at 3120 Frederick Avenue in Baltimore, MD, with a team of five employees and a single product line of evaporative condensers.

Today, the company's portfolio includes factory-assembled and field-erected cooling towers, closed-circuit coolers, evaporative condensers, air-cooled solutions, advanced water treatment systems and large-scale equipment for power plants and data centers.

EVAPCO has built a vertically integrated global footprint supporting customers across the world. It now operates 34 global locations across 14 countries, including 28 factories in 11 countries, complemented by numerous subsidiaries.

The company's growth and market leadership are underpinned by a strong commitment to research, testing and intellectual property. It holds more than 500 active patents worldwide

and subjects every solution to rigorous research and performance testing to help ensure maximum efficiency, reliability and long-term value. These efforts support the company's strong sustainability goals, focusing on higher system efficiency, reduced resource consumption and environmentally responsible cooling technologies. Equally important, Generations of dedicated employee owners have driven the company's culture of innovation, service and continuous improvement.

"EVAPCO's success over the past 50 years is rooted in our commitment to quality, innovation and the long-term relationships we've built with our customers and sales partners," said Jamie Facius, Marketing Vice President, EVAPCO. "As we look to the future, we're investing in technologies and services helping our customers meet demanding efficiency, sustainability and reliability goals." For more information, visit <https://www.evapco.com>.



EVAPCO's world headquarters in Taneytown, MD

Daikin Applied Announces Leadership Updates to Strengthen Customer Support and Advance Strategic Priorities

Daikin Applied appointed Yu Nishiwaki as its new President and CEO, James Moe as COO and Hirokazu Hirao as COO of Manufacturing. The appointments strengthen the company's operating model as it continues to scale its capabilities to support customers and advance its strategic priorities for fiscal year 2026 and beyond.

"It is an honor to serve as President and CEO of Daikin Applied," said Nishiwaki. "The demands on today's built environment are rapidly evolving. As we look ahead, we will continue strengthening customer relationships, advancing innovation and empowering our teams to deliver lasting value for the people and industries we serve."

Nishiwaki, who has served as the company's COO since 2023, will now lead the organization in its next phase of growth. This appointment signals a strategic focus on enhancing operational execution and manufacturing excellence to meet Daikin Applied's ambitious growth aspirations. Nishiwaki brings nearly three decades of experience with the company.

James Moe has been instrumental in driving growth and profitability since joining the company in 2016. In this new role, Moe will unite Daikin's Air Handling, Chiller and Applied Terminal Systems business units with his current oversight of sales, service, solutions and Alliance Air Products.

Hirokazu Hirao joins the company after more than 37 years with Daikin Industries, most recently serving as the General Manager of the company's global Applied Solutions business division, where he led efforts to expand Daikin's solutions business. For more information, visit <https://www.daikinapplied.com>.



Yu Nishiwaki, James Moe and Hirokazu Hirao of Daikin Applied (left to right)

Trane Technologies Appoints Donny Simmons as Chief Operating Officer to Drive Company Alignment and Accelerate Growth

Trane Technologies appointed Donny Simmons as Chief Operating Officer. In this expanded role, Simmons will oversee the company's regional business units and operations, driving tighter business and operational alignment and accelerating execution of the company's growth strategy.

Since launching as a pure-play climate innovation company in 2020, Trane Technologies has nearly doubled its annual revenue. Concurrently, the external landscape has rapidly evolved, with the global energy transition, advancements in climate innovation and the acceleration of artificial intelligence creating unprecedented market opportunities. By creating stronger alignment across its regional businesses and operations, Trane Technologies is positioned to capture these opportunities with greater speed and agility.

Simmons is a 25-year veteran of the company with a proven track record of delivering

consistent, profitable growth. Most recently, he served as Group President of the Americas region, overseeing a broad portfolio including commercial and residential HVAC, transport refrigeration and life science solutions.



*Donny Simmons, Chief Operating Officer,
Trane Technologies*

Since joining the company in 2001, Simmons has led several of its largest businesses, including Commercial HVAC North America and EMEA, as well as several global industrial businesses. Simmons has extensive experience managing complex, global operations and brings a holistic perspective to the COO role, having held key leadership positions across general management, sales, manufacturing and finance.

"Donny's appointment is an important step in our growth journey," said Dave Regnery, Chair and CEO, Trane Technologies. "By bringing our regional businesses and operations together under his leadership, we will foster deeper collaboration, strengthen our business operating system and accelerate execution of our strategy. Donny's strategic leadership, deep understanding of our businesses and strong operational mindset make him uniquely positioned to drive our next phase of growth." For more information, visit <https://www.tranetechnologies.com>.

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NEWS / Industrial Energy & Water Conservation

Xylem Reports 16% Reduction in Scope 1 and 2 Emissions in 2025

As global water challenges intensify, efficient and resilient water management is more critical than ever. Xylem, a Fortune 500 global water solutions company, has released its 2025 sustainability report, demonstrating how customer-driven innovation is transforming sustainability commitments into measurable performance outcomes for communities and the environment.

The company reported a 16% reduction in Scope 1 and 2 (market-based) greenhouse gas emissions since 2023, progressing toward a 42% reduction target by 2030. It saw a 15% improvement in water efficiency since 2023, progressing toward a 30% reduction goal by 2030.

Xylem was recognized for its sustainability efforts, earning a place on the CDP Climate Change A List. CDP is a global non-profit running the world's only independent environmental disclosure system, which partners with leaders in enterprise, capital, policy and science. Over 24,800 companies around the world disclosed data through CDP.

The company's 2030 plan prioritizes areas that will have significant impact for customers and communities, such as lower-carbon product designs, transparent lifecycle data and incorporating emissions considerations into innovation.

"Our sustainability progress starts with helping customers do more with water," said Matthew Pine, CEO, Xylem. "By combining innovation, data and expertise, we're enabling communities and industries to build more resilient water systems, advance water stewardship and create value in a changing global economy."

"This work is powered by our people," said Claudia Toussaint, Chief People and Sustainability Officer, Xylem. "By investing in talent, leadership and a values-driven culture, we're building the capabilities needed to scale impact and deliver on our commitments for customers, communities and the environment." For more information, visit <https://www.xylem.com>.

Baxter Announces Target for Net-zero GHG Emissions Across Scope 1 and 2 by 2050

Baxter International, a global medtech leader manufacturing critical healthcare products, published its 2025 sustainability report. It highlights the company's progress across key priorities, including strengthening collaboration with healthcare partners to improve patient care, driving operational efficiency and environmental sustainability and advancing a culture of safety and well-being for employees.



Baxter's North Cove manufacturing facility in Marion, NC

The company strengthened its approach to sustainability governance with the establishment of its first Chief Sustainability Officer role and newly created sustainability team, enhancing coordination and accountability across the enterprise. Baxter has also refreshed its sustainability strategy and reporting to reflect a more forward-looking approach to long-term value creation for its stakeholders.

The refreshed areas of focus led to a new set of targets designed to drive measurable progress, replacing the 2030 commitments previously established. New targets include net-zero greenhouse gas emissions (GHG) across Scope 1 and Scope 2 by 2050, aligned with a 2.7°F (1.5°C) science-based target, and 100% renewable electricity by 2040.

"When I joined Baxter as its first Chief Sustainability Officer, I saw firsthand a culture grounded in care, collaboration and an unwavering commitment to patients," said Renae Kezar, Chief Sustainability Officer, Baxter. "Sustainability is essential to enabling resilient healthcare delivery. Our sustainability strategy is designed to help ensure safe, reliable care while addressing the challenges facing healthcare and communities globally." For more information, visit <https://www.baxter.com>.



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Promega Receives SBTi Validation for Near-Term, Science-Based Targets

Promega Corporation received approval from the Science Based Targets initiative for its near-term emissions reduction targets, developed to reflect the current status of climate science. SBTi is a corporate climate organization that develops standards, tools and guidance for setting greenhouse gas emissions reductions targets in line with what is needed to avoid the worst impacts of climate change.

The Science Based Targets initiative has approved the following near-term targets: Reduce absolute Scope 1 and 2 emissions by 47% by 2030, from a 2023 baseline. Reduce Scope 3 emissions by 42% by 2030, from a 2023 baseline, focused on capital goods and business travel. By 2030, ensure 67% of suppliers by spend in purchased goods and upstream transportation have committed to SBTi or have published SBTi-aligned reduction targets.

Promega recently achieved 100% renewable electricity across its global operations, a key step toward meeting its Scope 1 and 2 reduction targets.

"These goals aren't just a commitment; they represent a verified plan with third-party accountability built in," said Corey Meek, Corporate Responsibility Program Manager, Promega. "Our SBTi-validated targets reflect a comprehensive understanding of our greenhouse gas emissions across our entire value chain and set a clear, science-aligned standard for what we aim to achieve by 2030." For more information, visit <https://www.promega.com>.

Azenta Publishes 2025 Environmental, Social and Governance Report

Azenta, a manufacturer of cold-chain sample storage equipment, laboratory consumables and automated systems for the biotechnology and pharmaceutical industries, published its annual environmental, social and governance (ESG) report, demonstrating continued progress against its key ESG priorities.

In 2025, the company disclosed its Scope 3 GHG emissions for the first time, establishing a value chain emissions baseline, setting the foundation for targeted reduction efforts and long-term climate action. It submitted near-term GHG reduction targets to the Science Based Targets initiative (SBTi) for validation, including a 45% absolute reduction in Scope 1 and 2 emissions and a 25% absolute reduction in Scope 3 emissions across key value chain categories by FY2033, from a FY2025 base year.

Azenta reduced its Scope 1 and 2 carbon footprint by approximately 40% in 2025 compared to a FY2022 base year (market-based), while sourcing 72% of its electricity from renewable sources.

The company advanced sustainable innovation with products like the BioArc™ Ultra, providing customers with cutting-edge solutions for large-scale, eco-friendly sample storage. It also expanded the Azenta Business System across global operations, equipping teams with tools and capabilities to improve quality, reduce waste and deliver better outcomes for customers. For more information, visit <https://www.azenta.com>.

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Understanding the ISA-7.0.01-1996 Instrument Air Standard

By Joe D'Orazio, National Sales
Manager, Kaeser Compressors

► In the world of industrial automation, compressed air isn't just a utility – it's the lifeblood of control systems. While plant air can usually have a little moisture, oil and particulate, instrument-grade compressed air must meet higher quality standards. Trace amounts of contaminants in the compressed air stream can quickly accumulate and cause costly production problems.

Here is what plant managers, engineers and operators need to know about defining, achieving and maintaining instrument-grade compressed air.

What Is Instrument Air? Defining the Standard

Instrument air is high-purity compressed air used to power pneumatic instruments, control valves

and automated systems. The global benchmark for this is ISA-7.0.01-1996 (Quality Standard for Instrument Air), established by the International Society of Automation (ISA).

It's widely believed instrument air requires desiccant compressed air dryers so a -40°F (-40°C) or lower pressure dewpoint is achieved. While this approach is definitely warranted in some circumstances, it's not needed in every situation. Going with desiccant compressed air dryers is the safer, conservative approach, but it comes with higher purchase and operating costs.

To be classified as instrument air, compressed air must meet four strict criteria:

- **Pressure Dew Point:** At least 18°F (10°C) below the lowest ambient temperature

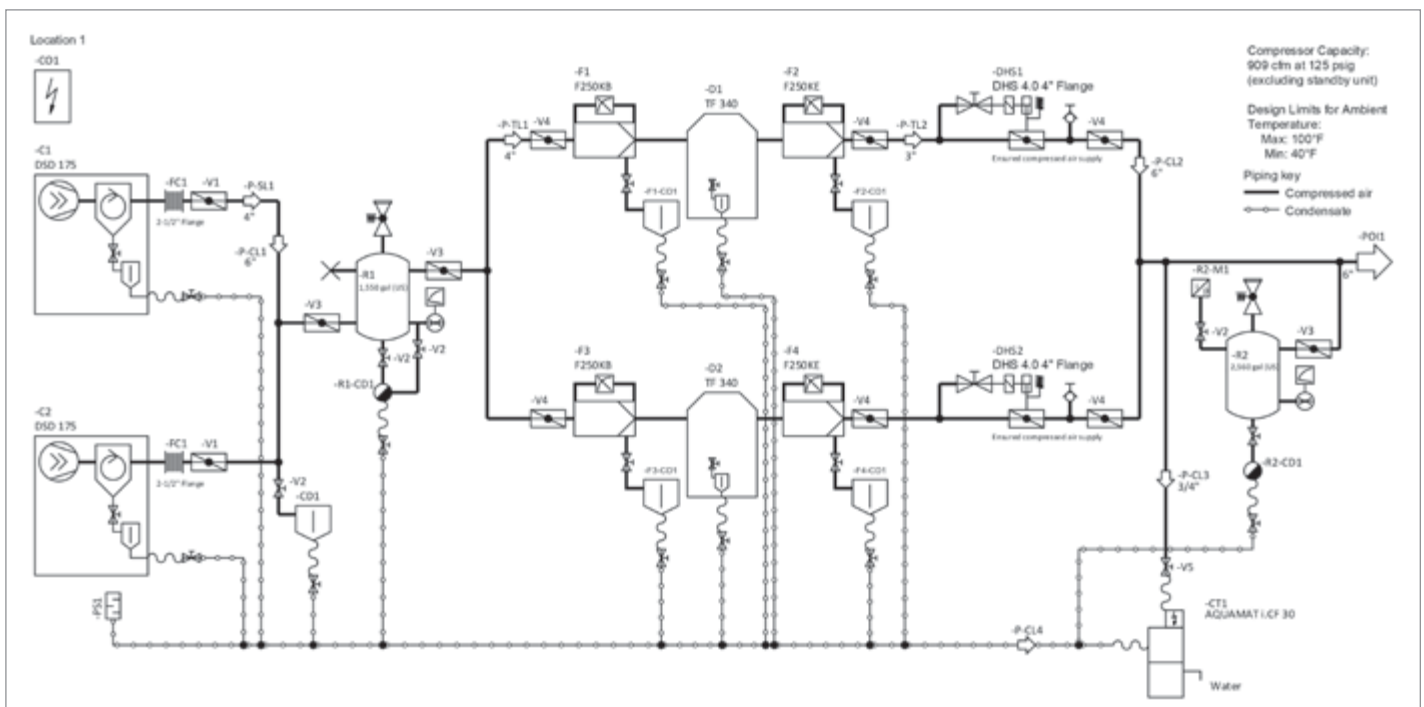
to which any part of the instrument air system is exposed. It should never exceed 39°F (4°C) at line pressure.

- **Particle Size:** Maximum particle size of 40 micrometers (microns) in the air stream.
- **Oil Content:** Maximum total oil content (liquid and vapor) of 1 ppm (w/w)
- **Contaminants:** Free of corrosive, flammable or toxic contaminants.

Who Set the Standard and How Has it Evolved?

The instrument air standard was originally developed by ISA (formerly the Instrument Society of America) to prevent pneumatic component failures. It evolved from prior ISA standards starting in 1956, and has not changed since 1996.

Above: An instrument air system with refrigerated compressed air dryers (all images courtesy of Kaeser Compressors).



A piping and instrumentation diagram for the system at the top of the page.

As modern manufacturing has adopted more sensitive, micro-pneumatic components and smart positioners, users and specifiers have become more stringent. In practice, ISA-7.0.01 has been somewhat supplanted by ISO 8573-1. For example, the ISA standard allows 1 ppm oil content, but this is considered dirty air in many plants. They apply stricter ISO grades as insurance, usually grades 1.2.1 or 1.4.1. Some even specify oil-free air compressors. This may not be strictly necessary for the instrument air in the plant, but if much of the plant air is also used in food, pharmaceutical or other sensitive applications, it's surely simpler (and likely more economical) than operating a separate instrument air system.

Why Instrument Air Matters: Verticals and Critical Touchpoints

If instrument air fails, automation fails. When a pneumatic valve gets stuck due to moisture or oil gumming up the internals, processes experience unsafe pressure spikes, product contamination or emergency shutdowns. Consult general guidelines for each industry when choosing compressed air treatment.

- **Chemical and Petrochemical:** Refineries and chemical plants rely on thousands of pneumatic control valves spread across vast outdoor pipe racks. A freeze-up or sticky valve can cause catastrophic safety hazards.
- **Pharmaceuticals and Life Sciences:** Air used for pill coating, packaging or valving must be ultra-pure. Oil or moisture contamination can ruin entire batches and violate FDA regulations.
- **Food and Beverage:** Used in automated sorting, bottling and packaging. Any contact between compressed air and the product demands strict adherence to instrument/food-grade standards to prevent microbial growth.
- **Power Generation:** Pneumatic actuators control critical steam and water valves. Reliability keeps the electrical grid stable. They also start and control natural gas-driven generators such as those used at the growing number of data centers.

Achieving Instrument Air: Dryers and Filtration

Raw compressed air is hot, wet and dirty. Turning it into instrument-grade air requires a combination of drying and filtration

equipment. To achieve the required dew points, facilities rely on two primary compressed air dryer categories:

Desiccant compressed air dryers can be heatless (using a portion of the compressed air as purge air to dry the adsorbent material, which wastes about 15% of the compressed air) or heated purge (using heated purge air to regenerate the desiccant, saving compressed air energy at the cost of electrical heat). Blower purge compressed air dryers experience short-term dewpoint spikes at certain times.

The effectiveness of heated purge and blower purge desiccant compressed air dryers is governed by the temperature and pressure of the air entering the dryer. The effectiveness of refrigerated compressed air dryers is also governed by the temperature of the ambient air. Dryer sizing must take these factors into account.

The Critical Filtration Chain for Instrument Air

Compressed air drying is useless without proper filtration. A standard instrument air train requires a multi-stage approach:

1. **Water Separator/Bulk Moisture Filter:** Removes bulk liquid water and large scale before it hits the compressed air dryer.
2. **Coalescing Filter (Pre-Filter to Dryer):** Catches fine oil mists and water droplets down to 0.01 microns or less. This protects desiccant beds from oil fouling, which ruins their ability to adsorb water.
3. **Particulate After-Filter (Post-Dryer):** Desiccant beads naturally abrade and create fine dust (called desiccant fines). A high-temperature particulate filter is placed after the desiccant compressed air dryer to catch these particles before they reach instruments.
4. **Activated Carbon Filter (Optional):** Removes oil vapors and odors. This is critical for the food and pharmaceutical verticals.

Determining and Optimizing for the Right Dew Point

One of the costliest mistakes a plant can make is over-specifying its dew point without

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>> Understanding the ISA-7.0.01-1996 Instrument Air Standard

realizing the energy and service cost penalties. Achieving a -40°F (-40°C) dew point with a desiccant compressed air dryer requires significantly more energy (either via compressed air purge loss or electrical heating elements or blowers) than running a refrigerated dryer at 38°F (3°C). Plant managers must balance operational surety with lifecycle costs, including purchase price, maintenance costs, repairs and energy consumption.

The golden rule for determining a plant's dew point comes from the ISA standard: The dew point must be 18°F (10°C) lower than the lowest ambient temperature the downstream piping and process equipment will ever experience.

Scenario A (Indoor Facility): A plant in a climate-controlled building where the temperature never drops below 65°F (18°C).

Calculation: $65^{\circ}\text{F} - 18^{\circ}\text{F} = 47^{\circ}\text{F}$ (8°C). Since the ISA maximum cap is 39°F (4°C), a properly sized refrigerated compressed air dryer achieving 38 – 45°F (3 – 7°C) pdp is acceptable and energy efficient.

Scenario B (Outdoor/Unheated Facility): A chemical plant in Ohio where winter temperatures can drop to -10°F (-23°C).

Calculation: $-10^{\circ}\text{F} - 18^{\circ}\text{F} = -28^{\circ}\text{F}$ (-33°C). A refrigerated compressed air dryer will fail here. Moisture in the air will condense and freeze, creating reliability issues in the facility. This facility selects a desiccant dryer rated for -40°F (-40°C).

Air Compressor Selection: Oil-Free vs Oil-Flooded

Both oil-flooded and oil-free air compressors are used in instrument air applications. There are significant cost implications for purchase, service and energy. Consider the following design questions when deciding between the two:

- Is there an industry- or company-specific standard? For instance, the 2011 ISPE (International Society of Pharmaceutical Engineering) Good Practice Guide for Process Gases requires a -40°F (-40°C) pdp and little to no hydrocarbon carryover.
- Will compressed air come in contact with the product?

- What is the consequence of contamination due to oil? What is the hourly cost to production if a sensor is contaminated due to oil carryover?
- Does the facility have the ability to shut down to replace dirty or clogged filters? Should the system be designed to allow maintenance to take place on any piece of equipment without the system being offline?

In either case, they require the correct compressed air dryer and proper filtration.

Determining Compressed Air Demand

Before selecting equipment, you must calculate total demand (cfm or m^3/min).

1. **Sum the Components:** Add up the air consumption of all pneumatic instruments, control loops and cylinders based on manufacturer datasheets.
2. **Apply a Load/Duty Factor:** Not every valve actuates at the same millisecond. Apply a concurrency factor (typically 50–70% for large instrument networks).
3. **Account for Future Growth and Leaks:** Add a 20–30% buffer for future plant expansion and an unavoidable 10–15% buffer for leaks.

Consider reliability and redundancy as you would for any compressed air system. A modular approach and/or variable speed drives can significantly reduce operating costs.

Case Study 1: The Coastal Food Packaging Plant

The Challenge: A humid, indoor packaging facility experiences frequent micro-valve failures on its sorting matrix, causing packaging misalignment.

The Selection: Total demand is calculated at 300 scfm. Because this is an indoor facility, a -4°F (-20°C) dew point isn't required, but oil-free compressed air may be required if air contacts food.

The Solution: A properly sized refrigerated compressed air dryer producing a 38°F (3°C) dew point, a multi-stage coalescing filtration array and a carbon vapor filter.

The Outcome: Valve failures dropped to zero, and the plant saved thousands in energy costs by avoiding an oversized desiccant compressed air dryer system.

Case Study 2: The Northern Oil Refinery

The Challenge: An oil refinery spans several outdoor acres in a region where winters regularly hit -15°F (-26°C). Main control lines are prone to freezing, shutting down critical process loops.

The Selection: Total instrument air demand is 1,500 cfm.

The Solution: A duplex skid design featuring two rotary screw air compressors (configured for 100% redundancy), dual desiccant compressed air dryers (achieving a $-40^{\circ}\text{F}/4^{\circ}\text{C}$ pdp), heavy-duty oil-coalescing pre-filters and particulate after-filters.

The Outcome: The desiccant compressed air system with -40°F (-40°C) pdp eliminated winter line freeze-ups.

Case Study 3: The Unmanned Station

The Challenge: Design and maintain an unattended compressed air system able to supply instrument-quality compressed air around the clock in all four seasons and alert personnel when the station is not operating.

The Selection: Total instrument air demand is 120 scfm.

The Solution: A fully enclosed compressed air station with thermostatic louvers, exhaust ductwork, two rotary screw air compressors, two heatless desiccant compressed air dryers and redundant filters, rated for both low and high temperature extremes at the elevation, with all key operating parameters (temperature, pressure, dewpoint and equipment alarms) remotely monitored via a cellular modem. This system features single-point connections for power, air and condensate.

To minimize footprint and installation costs, modern plants may opt for pre-engineered, pre-built instrument air skids. These modular systems integrate air compressors, receivers, filters, compressed air dryers and measurement devices onto a single structural frame, complete with all interconnecting piping and wired to NEC

standards with single-point utility connections. These options often save time and money if a building needs to be modified or the installation is in a remote location. They also ensure the system's components work together.

Maintenance and Concerns for Plant Managers

An instrument air system is only as reliable as its maintenance schedule. Plant managers should keep a strict eye on the following:

Condensate Drain Management. The best filters in the world are useless if their automatic drains are clogged. If a drain valve fails to open, water and other contaminants re-enter the air stream. Inspect drains frequently. Some have function alarms that can be monitored remotely.

Filter Element Differential Pressure. As filters catch hydrocarbons, they create pressure drop. Running air through a clogged filter forces the air compressor to work harder, increasing operating costs. Replace elements as needed on a regular schedule. As with drains, alarm devices are available for in-line filters.

Desiccant Degradation. Over time, desiccant beads break down. Monitor dew point sensors continuously. A rising dew point indicates it's time to replace the desiccant beds.

Leak Detection Audits. Pneumatic fittings and valve packings inevitably develop leaks. Because instrument air is expensive to produce, an aggressive leak detection program ensures operations and can save a facility tens of thousands of dollars annually.

The Ultimate Yield on Clean Air

At first glance, designing and maintaining a true instrument-grade compressed air system can look like an expensive hurdle. The specialized compressed air dryers, duplicate filtration and precise monitoring equipment represent real capital and operational costs. However, looking at these systems solely as an expense is a mistake. In modern manufacturing, high-purity air is an insurance policy against unplanned downtime (preventing a single line stoppage caused by a stuck pneumatic valve can instantly pay for a year of premium filtration), product spoilage (keeping oil and water out of packaging and process lines protects batch integrity and preserves brand reputation) and asset degradation (clean, dry air extends the

lifespan of sensitive pneumatic actuators, smart positioners and control valves by years).

Clean air equals smooth operations. By basing your system's dew point on your lowest ambient temperatures – rather than on desiccant compressed air dryers by default – you can optimize your energy footprint. Pair this smart design with a disciplined maintenance routine focusing on drain integrity, filter replacement and routine leak audits, and your instrument air system will become the reliable backbone of your facility. **BP**

About the Author

Joe D'Orazio is the National Sales Manager for Kaeser Compressors. With 29 years in the compressed air industry, he has helped thousands of customers improve the reliability, productivity and

efficiency of their compressed air systems. Joe holds a Bachelor of Science in Mechanical Engineering from Clarkson University and a Master's in Business Administration from the University of Florida.



About Kaeser Compressors

Kaeser Compressors is a leader in reliable, energy-efficient compressed air equipment and system design. It offers a complete line of industrial air compressors as well as compressed air dryers, filters, SmartPipe™, master controls and other system accessories. Kaeser also offers blowers, vacuum pumps and portable gasoline and diesel screw air compressors. Its national service network provides installation, rentals, maintenance, repair and system audits. Kaeser is an ENERGY STAR Partner. For more information, visit <https://us.kaeser.com/>.

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The CABP Interview: Sauer Compressors USA, Inc. President, CEO and Chairman of the Board, Don Eaton

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

Bill Smith, Sales Manager for Compressed Air Best Practices® Magazine, sits down with Don Eaton, President, CEO and Chairman of the Board, Sauer Compressors USA, Inc., to talk about Sauer's history, its vast range of high-pressure compressors and its promise to deliver the ultimate customer journey in partnership with distributors through training and continued education.

► Backed by decades of engineering expertise and a proven reputation for reliability, Sauer Compressors USA, Inc. provides complete medium- and high-pressure air and gas compression solutions to markets including defense, power generation, oil and gas, CNG, power distribution, research and development, aviation, metallurgy, safety and commercial shipping.

In June 2026, Bill Smith, Sales Manager, *Compressed Air Best Practices® Magazine*, visited the Sauer Compressors USA, Inc.'s Headquarters and spoke with Don Eaton, President, CEO and Chairman of the Board, as part of this magazine's executive leadership interview series. In this interview, we learn about Eaton's career with Sauer Compressors USA, Inc., the company's history, recent strategic investments and the importance of distributor partnerships in the medium- and high-pressure air compressor industry.

Best Practices: Tell us about your background and what led to your career at Sauer.

Don Eaton: I grew up in York County, PA, and attended Penn State University. In 2006, my former boss had been hired as the CEO of

Sauer Compressors USA, Inc. He was looking for someone to help build the business, and I was looking for my next opportunity. The

timing was perfect, so I moved to Maryland and joined his team of 11 employees. I started as General Manager, and I was involved in



Above: Sauer Compressors USA, Inc. supplies specialized air compressors for U.S. Navy vessels, such as the U.S.S. Gerald R. Ford, a nuclear-powered aircraft carrier.

Don Eaton, President, CEO and Chairman of the Board, Sauer Compressors USA, Inc. with a three-stage air and gas compressor capable of up to 640 psig (40 barg).

nearly every aspect of the business, with a strong focus on sales and operations. Five years later, I was appointed as the President and CEO and have been driving the North American segment of the Sauer Compressors Group ever since. As we have grown to nearly 150 employees, I want to continue to build a culture where people enjoy what they do and are proud to be part of the company.

Best Practices: Can you tell us about Sauer Compressors' history?

Don Eaton: The Sauer Group was founded in 1884 as a brass foundry and began manufacturing air compressors in the 1930s. Sauer Compressors USA, Inc. was established in 1998 after Sauer was awarded the contract to replace all the high-pressure air compressors (HPACs) for the United States Naval Aircraft Carrier Program. As part of the contract, Sauer was required to provide a U.S.-based company that could supply local parts, service and technical support for mission-critical equipment aboard naval vessels. The success of that initial program became the foundation of Sauer USA. Today, we continue to support the United States Navy and Department of Defense through a dedicated team focused on defense contracts, ensuring mission-critical air compressors remain operational throughout their service life.

"Sauer Compressors USA, Inc. was established in 1998 after Sauer was awarded the contract to replace all the high-pressure air compressors (HPACs) for the United States Naval Aircraft Carrier Program. As part of the contract, Sauer was required to provide a U.S.-based company that could supply local parts, service and technical support for mission-critical equipment aboard naval vessels."

— Don Eaton

Best Practices: How did the company expand and attract industrial customers?

Don Eaton: In 2008, we were ready to diversify and strategically targeted the industrial markets.



David Swartz, Industrial Services Business Development Manager, servicing an air compressor.

We were well known in the Navy, and people assumed since the air compressors were complex and robust, that they were only suitable for defense applications. With a small team, we were able to get into the right conversations and prove to the industry that our air compressors could fit into just about any application that fell within our pressure range.

In 2016, we established Sauer Compressors Mexico. We recognized the importance of having a local presence with a team that understood the market, the culture and the needs of our customers. We continued that strategy in 2020 with the opening of Sauer Compressors Canada, where growing naval opportunities make the region an important part of our long-term growth plan.

A Strategy for Compressed Air Success in North America

Best Practices: What can you tell us about Sauer's recent global rebranding and commitment to the compressed air industry?

Don Eaton: We now have one unified brand, including a new logo and consistent

messaging. While we are part of the Group, Sauer Compressors USA, Inc. is still a U.S.-based company. We will continue to have the customer support that the industry has come to expect from us, while being able to take advantage of the resources that the Group can offer.

We continue to grow year after year, and we are making strategic investments to better support our customers. For example, we are in the process of expanding our test bay to increase our in-house testing capabilities with higher capacities and unique gases. The construction will be done by the end of this year. Over the next few years, we will continue investing in additional infrastructure, personnel and resources. All our decisions are driven by our mission to provide the ultimate customer journey.

Best Practices: What can you tell us about Sauer's global leadership team?

Don Eaton: We are a privately held third-generation family-owned business. It is important that we preserve the values and

» The CABP Interview: Sauer Compressors USA President, CEO and Chairman of the Board Don Eaton

culture that have made us successful in the past while making strategic decisions that can take us to the next level in the future. The Group's corporate leadership gives Sauer USA the freedom to drive growth for North America.

Best Practices: Tell us about your portfolio of industrial air compressor technology.

Don Eaton: We specialize in medium- and high-pressure air and gas compressors ranging

from 100 psig to 7,250 psig (7 to 500 barg). Our portfolio includes oil-lubricated, oil-free, air-cooled and water-cooled compressors that can be supplied as individual compressor blocks or as fully integrated systems. Many of our OEM partners purchase compressor blocks to incorporate into their own equipment, while other customers rely on us to deliver complete engineered solutions. These systems can include weather- or sound-dampening enclosures, specialized controls and other application-specific features.

Best Practices: Describe Sauer USA's headquarters in Stevensville, MD.

Don Eaton: Our campus is situated on the shores of the Chesapeake, just beyond the Bay Bridge as you enter Maryland's Eastern Shore. Our business is built around delivering air and gas compressor solutions tailored to each customer's application. While the compressor blocks are manufactured in Germany, we maintain local inventory here. We also have a



A high-pressure air compressor enclosure on the production floor.

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significant inventory of spare parts on hand so we can respond quickly to customer needs.

Our in-house engineering, drafting and design teams work closely with customers to develop custom air and gas compressor packages that meet their exact specifications. Every system is thoroughly tested before shipment, and our service network across North America provides ongoing support to ensure continuous operation throughout the life of the equipment.

*"Reliability and up-time
are the foundation of everything
we do because that is what
our customers value most.
They need equipment that
performs consistently throughout
its service life."*

— Don Eaton

Best Practices: Sauer has a rental hub in Logan, Utah. Why did you open that facility, and what does it mean to have a new location with a vast rental fleet?

Don Eaton: Rental equipment allows us to respond when customers face unexpected equipment failures or urgent operational needs, making us a stronger partner when time is critical. While we successfully managed rentals from Maryland for many years, we realized that we needed a more direct route to get rental equipment to our customers in the western U.S. faster.

The shorter delivery times help minimize customer downtime, keep operations running and ensure we are there when our customers need us most. While the facility supports our long-term growth, its greatest value is improving the level of service and responsiveness we can provide.

Best Practices: What trends drive the high-pressure air compressor market? What are plants asking for?

Don Eaton: Reliability and up-time are the foundation of everything we do because that is what our customers value most. They need equipment that performs consistently throughout



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Sauer Compressors USA, Inc.'s rental warehouse in Logan, UT.

its service life. As investment continues across the United States in areas such as power generation, naval expansion and industrial infrastructure, the demand for dependable air compressors continues to grow.

Regardless of the industry or application, our customers expect equipment that delivers exceptional reliability, operates continuously between scheduled maintenance intervals and keeps their operations running without interruption. That is the standard we strive to achieve every day.

Training Compressed Air System Sales and Service Companies

Best Practices: What are you looking for when you bring on a new distributor?

Don Eaton: We look for partners that want to expand their portfolio by entering the medium- and high-pressure air compressor market. For many distributors, this represents an opportunity to diversify their business while generating recurring lifetime revenue through equipment sales, spare parts, service and long-term customer support.

Because many of our partners have traditionally focused on low-pressure compressed air systems, we invest heavily in education and training. We provide sales and service training, introduce them to the industries and applications we serve and equip them with technical knowledge and confidence to identify new opportunities. Rather than just adding a product line, we work

alongside our distributors as true partners, helping them build expertise, grow their business and deliver lasting value to their customers.

Best Practices: How does Sauer provide high-pressure air compressor service training?

Don Eaton: Training is a key part of how we support our distributor network. When a distributor begins selling a particular air compressor model or series, we provide specialized training so their service technicians can confidently maintain and support that equipment. Training is offered at our dedicated training center in Maryland or at the distributor's location. At the end of the course, technicians receive certification for the specific air compressor series they have been trained to service.

Depending on the model, training typically lasts three to four days and combines classroom instruction with extensive hands-on experience. Even after certification, our technical support team is available to answer questions and assist with troubleshooting in the field. Our goal is to give distributors both the knowledge and the ongoing support they need to provide exceptional service throughout the life of the equipment. **BP**

For more information, visit <https://www.sauerusa.com>.



Joshua Peter, Naval Business Development Manager, conducts a training class for new service technicians.

To read similar **Air Compressor Technology** articles, visit <https://www.airbestpractices.com/technology/air-compressors>.



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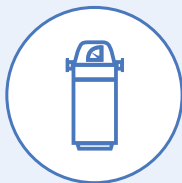
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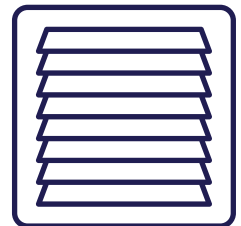
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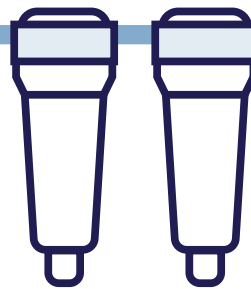
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MSHA Regulations for Safe Compressed Air Operation

By Paul Edwards, President, Compressed Air Consultants

► This article covers a small portion of the documented hazards, regulatory requirements and potential citations tied to compressed air in mining settings. It pulls from Mine Safety and Health Administration (MSHA) standards, case literature and established safety guidance. It should be read as an orientation and not as a compliance manual.

The purpose is to provide background information so the reader can interact more intelligently with clients and qualified safety professionals. The miner must take responsibility for their own safety, which requires an understanding of the current MSHA standards in addition to the site's specific risks. That's because regulations change and enforcement priorities shift, and the details of the facility you're working in matter more than anything written here.

The article shares the standards without comment on who is considered a miner and what record-keeping is required.

Creating a Culture of Safe Compressed Air Use in Mining

DuPont was a pioneer in safety training, starting with the publication of work rules in 1811, establishing the concept that safety is a management responsibility. As the son and the grandson of lifetime DuPont employees, the concept was part of our upbringing to the point where we wore steel-toe boots to cut the grass.

Mining is among the most hazardous industries for a compressed air professional. As a consequence, it's vital that companies working in mine sites ensure all employees have the full and appropriate training on safety. In many cases, it's a requirement. While there are cases where it's not a requirement, the training is still helpful and recommended for installing a safety-first culture.

§ 56.14100 Safety defects; examination, correction and records.

(a) Self-propelled mobile equipment to be used during a shift shall be inspected by the equipment operator before being placed in operation on that shift.

(b) Defects on any equipment, machinery, and tools that affect safety shall be corrected in a timely manner to prevent the creation of a hazard to persons.

(c) When defects make continued operation hazardous to persons, the defective items including self-propelled mobile equipment shall be taken out of service and placed in a designated area posted for that purpose, or a tag or other effective method of marking the defective items shall be used to prohibit further use until the defects are corrected.

(d) Defects on self-propelled mobile equipment affecting safety, which are not corrected immediately, shall be reported to and recorded

by the mine operator. The records shall be kept at the mine or nearest mine office from the date the defects are recorded, until the defects are corrected. Such records shall be made available for inspection by an authorized representative of the Secretary.

Subsection (b) is the broadest and one of the most cited categories, and for that reason, it's important to understand. It's deliberately vague as it's a performance-based standard. No document can cover every potential hazard a mine site and its operators can create. The upside of this is safety, but the downside is that the MSHA inspector has quite a bit of discretion. That discretion makes for a safer working environment, but it also creates a need for a challenge system for mine site operators when they believe the inspector has gone too far. In one case, a mine was written up for missing a light bulb in a refrigerator, as it presented a shock hazard.



An unreadable pressure gauge

Above: Sand at a surface mine

>> MSHA Regulations for Safe Compressed Air Operation

Some of the more common issues we encounter in mine sites are:

- Unreadable pressure gauges: This is one of the most common issues encountered, especially on remote receiver tanks. Often, the gauges are busted, or the lens has clouded over.
- Deteriorating plastic bowl guards: This is one of the most hazardous problems we see in the industry, and it often goes undetected. While it's rare to see, old plastic guards can fail catastrophically. Ultraviolet light, extremely dry air and some air compressor lubricants can lead to weakening of the plastic. Some vendors offer a double plastic wall, which protects equipment from dry air and air compressor lubricant. We haven't seen evidence regarding degradation in ultraviolet light. For that reason, metal bowl guards are recommended.
- Safety blow-off guns: While this is associated with open blowing towards personnel, it belongs in this category, as well. One of the most popular safety blow guns is the Long John 75, which has a safety tip on it. Operators often use the tip as a mechanical clearance device in combination with the compressed air, which creates a little bit of wear each time it encounters material. Over time, it's common to see these tips worn away.
- Delaminating hoses: Hose safety has its own subsection, which doesn't address the degradation of the hose itself. That falls under this section. Delaminating can often be seen as bubbles forming underneath the hose, as the interior lining has failed.
- Lack of drainage on tanks: The more frequent problem here is a broken manual valve on the drain, a plugged discharge or inadequate access to the manual drain.
- Degraded piping downstream of an improperly maintained deliquescent dryer: This occurs less and less, but

piping exposed to poorly maintained deliquescent dryers can degrade significantly. In one mine site, an operator we worked with attempted to put a Chicago fitting on a pipe downstream of a poorly maintained deliquescent dryer. As he wrestled with the fitting, the pipe failed, spraying bits of rust and metal through the area.

56.13010 Reciprocating-type air compressors

(a) Reciprocating-type air compressors rated over 10 horsepower shall be equipped with automatic temperature-actuated shutoff mechanisms which shall be set or adjusted to the compressor when the normal operating temperature is exceeded by more than 25 percent. (b) However, this standard does not apply to reciprocating-type air compressors rated over 10 horsepower if equipped with fusible plugs that were installed in the compressor discharge lines before November 15, 1979, and designed to melt at temperatures at least 50 degrees below the flash point of the compressors' lubricating oil.

Since rotary screw air compressors are the primary source of air for most mine sites, there are often reciprocating compressors serving dedicated applications. The most common location where this standard applies is in maintenance or tire shops, where the higher pressure requirement of torque wrenches requires reciprocating air compressors. Most of these operations have 5-10 horsepower (hp) air compressors, bringing them below the threshold. However, some shops have larger reciprocating air compressors that are above the threshold but have not been equipped with a high air temperature switch. We know of one citation in the half-dozen or so examples where these air compressors are present.

§ 56.13012 Compressor air intakes

Compressor air intakes shall be installed to ensure that only clean, uncontaminated air enters the compressors.

Mine sites are often filled with dirt, and adequate maintenance of the inlet filter is likely to meet this requirement, but it's still at the inspector's discretion. Where the surrounding air is reasonably clean and contains no harmful vapors, fumes or excessive process dust, the air

compressor's properly maintained OEM inlet filter should ordinarily satisfy §56.13012. The mere presence of an inlet filter, however, would not cure an intake located in contaminated air or fitted with filtration inadequate for the actual environment.

Some mine processing facilities have the potential for ingesting diesel fumes (load-out areas) or chemical contamination (gold, copper), so those should be dealt with on a one-by-one basis.

One area of concern is the potential increase in the concentration of vapors in the air compressor lubricant. It would take a chemist or chemical engineer to figure out what the potential interactions between the lubricant and the vapor are through the whole cooling cycle. It's better to test lubricant for contamination on a regular basis and keep air compressors from ingesting chemical vapors.

§ 56.13011 Air receiver tanks

Air receiver tanks shall be equipped with one or more automatic pressure-relief valves. The total relieving capacity of the relief valves shall prevent pressure from exceeding the maximum allowable working pressure in a receiver tank by not more than 10 percent. Air receiver tanks shall also be equipped with indicating pressure gauges that accurately measure the pressure within the air receiver tanks.

Most operations do a strong job with receiver tank maintenance. However, there are plants whose treatment of receiver tanks leaves them vulnerable to multiple citations. These include:

- Non-ASME pressure vessels: 30 CFR 56.13001 requires all boilers and pressure vessels be constructed, installed and maintained in accordance with the ASME Boiler and Pressure Vessel Code. ASME code requires a stamp when pressure is greater than 15 psig (1.0 barg) and the diameter is greater than 6 inches. The most common citable location where this happens is European-produced pressure vessels for low-pressure (29-44 psig, 2-3 bar) process bag houses. A second issue is when plants create homemade distribution manifolds for Chicago fittings.

- Faulty or missing valves and pressure gauges: Every storage tank should have both of these.

Two areas worth considering are safety valve testing and pressure gauges on rotary screw air compressor separators.

- The MSHA standard doesn't mention the frequency of testing of safety valves, so it may come down to the manufacturer's recommendation, the inspector's discretion, the state's requirements or service conditions. Some of the valves one encounters in the field are covered in dust and likely haven't been tested in years. Safety valves should be placed where it's easy for workers to remove them for testing. The discharge of the valve should be positioned so as not to endanger a worker's safety if and when the valve discharges.
- Several manufacturers use a pressure transducer to display separator-ump pressure on the air compressor control panel. While this may satisfy the functional requirement for pressure indication, it raises difficult questions. The separator is, or should be, an ASME pressure vessel, although it's not entirely clear whether or not it would also be classified as an "air receiver tank" under the standard. If the controller or display fails while the separator remains pressurized or the air compressor continues to operate, the vessel may be left without a functioning pressure indication. At that point, continued operation could fail the standard and would, at a minimum, create a safety-related defect requiring prompt correction.

56.13021 High-pressure hose connections

Except where automatic shutoff valves are used, safety chains or other suitable locking devices shall be used at connections to machines of high-pressure hose lines of 3/4-inch inside diameter or larger, and between high-pressure hose lines of 3/4-inch inside diameter or larger, where a connection failure would create a hazard.

This hazard is one of the most frequent in mine sites when it comes to compressed air. The two most common safety-related pieces on hoses tend

to be safety pins or whip checks. There are plenty of videos on the internet about the danger a decoupled hose presents to an employee.

Safety pins are the most common safety element and prevent the hose from twisting on itself. The pins have an interference fit, which would likely be considered a "suitable locking device." There is precedent for this. In one ruling, the judge reviewing an inspector's report wrote, "The evidence consists mainly of the testimony of the inspector and is not in dispute on most aspects of the charge. The inspector did testify that he found – or that he observed the jack leg drill in use, and while he did not see an automatic shutoff valve, he believed that there may [not] have been one. He also observed that the machine was of the type that normally requires the three-quarter inch inside diameter hose. He also observed that the jack leg drill did not have the safety chain or other suitable locking device. A locking pin was acceptable to the inspector, and abatement consisted of inserting of the locking pin." (W.A Bowles vs. Sol (MSHA))

This is not legal advice, and the judge did not expressly hold that every locking pin is automatically a suitable device in all cases. In this specific case, he considered the installation of a locking pin as satisfactory abatement of the violation.

With that as background, safety chains are a clear upgrade on locking pins as they provide a second level of protection. The pin prevents rotation and may prevent decoupling, but offers no restraint if the hose separates. A properly installed safety chain limits the movement of the hose and reduces any whipping action, reducing the likelihood of personnel injury and secondary damage to the surrounding equipment.

§ 56.13015 Inspection of compressed-air receivers and other unfired pressure vessels

(a) Compressed-air receivers and other unfired pressure vessels shall be inspected by inspectors holding a valid National Board Commission and in accordance with the applicable chapters of the National Board Inspection Code, a Manual for Boiler and Pressure Vessel Inspectors, 1979. This code is incorporated by reference and made a part of this standard. It may be examined at any Metal and Nonmetal Mine Safety and Health District Office of the Mine Safety and Health Administration, and may be obtained from the publisher, the National Board of Boiler and



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>> MSHA Regulations for Safe Compressed Air Operation

MSHA Definitions and Requirements

Training R30 CFR § 46.2 — Definitions

(g) Miner means:

(1) Any person, including any operator or supervisor, who works at a mine and who is engaged in mining operations. This definition includes independent contractors and employees of independent contractors who are engaged in mining operations; and

(2) Any construction worker who is exposed to hazards of mining operations.

The definition of “miner” does **not** include scientific workers; delivery workers; customers (including commercial over-the-road truck drivers); vendors; or visitors. **This definition also does not include maintenance or service workers who do not work at a mine site for frequent or extended periods.**

MSHA Guidance on “Frequent or Extended Periods”

While the regulation itself uses the terms “frequent or extended periods,” MSHA provides the following definitions in its official compliance guidance:

- **“Extended”** exposure means exposure to hazards at mining operations of **more than five consecutive work days**.
- **“Frequent”** exposure is defined as a pattern of exposure to hazards at mining operations occurring **intermittently and repeatedly over time**.

Summary

- Workers (including contractors) who are on site for **more than 5 consecutive work days** or who have a recurring pattern of exposure are generally considered **miners** and must receive full Part 46 training.

- Those who do not meet the frequent or extended threshold are not considered miners and only require site-specific hazard awareness training.

Requirements

30 CFR Part 46 governs training for miners at surface metal and nonmetal mines.

§ 46.3 Training plans You must develop and implement a training plan that is approved by MSHA and that addresses the training requirements in this part for all miners.

§ 46.5 New miner training You must provide each new miner with no less than 24 hours of training...

§ 46.6 Newly hired experienced miner training You must provide each newly hired experienced miner with training...

§ 46.8 Task training You must provide task training... to each miner before the miner performs a new task or a task that has changed and that affects the miner’s health or safety.

§ 46.9 Annual refresher training You must provide each miner with no less than 8 hours of annual refresher training...

Note: Task training under § 46.8 is particularly relevant for work involving compressed air systems, compressors, receivers, and boilers. Parallel training requirements exist under 30 CFR Part 48 for operations covered by that part.

Recordkeeping/Paperwork Requirements

Subpart L – Compressed Air and Boilers

§ 56.13015(b) Inspection of compressed-air receivers and other unfired pressure vessels. Records of inspections shall be kept in accordance

with the requirements of the National Board Inspection Code, and the records shall be made available to the Secretary or his authorized representative.

§ 56.13030(c) Boilers Records of inspections and repairs shall be kept in accordance with the requirements of the ASME Boiler and Pressure Vessel Code and the National Board Inspection Code. The records shall be made available to the Secretary or his authorized representative.

General Equipment and Safety Records

§ 56.14100(d) Safety defects; examination, correction, and records Defects on self-propelled mobile equipment affecting safety, which are not corrected immediately, shall be reported to and recorded by the mine operator. The records shall be kept at the mine or nearest mine office from the date the defects are recorded until the defects are corrected. Such records shall be made available for inspection by an authorized representative of the Secretary.

Training Records

30 CFR § 46.9 Records of training (a) You must record and certify on MSHA Form 5000-23, or on a form that contains the information listed in paragraph (b) of this section, that each miner has received training required under this part.

(b) The form must include: (1) The printed full name of the person trained; (2) The type of training, the duration of the training, the date the training was received, and the name of the competent person who provided the training; (3) The name of the mine or independent contractor, MSHA mine identification number or independent contractor identification number, and location of training...

Records must be maintained and made available for inspection as required.

Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229. (b) Records of inspections shall be kept in accordance with the requirements of the National Board Inspection Code, and the records shall be made available to the Secretary or his authorized representative.

This standard is self-evident.

§ 56.13017 Compressor discharge pipes

Compressor discharge pipes where carbon build-up may occur shall be cleaned periodically as recommended by the manufacturer, but no less frequently than once every two years.

Pipeline fires have been significantly reduced in the last 40 years as the switch to rotary screw air compressors with high flashpoints has been adopted in many mine sites. There are still a few reciprocating air compressors running on mineral oils, and we have observed one pipeline fire in our company's 23 years. These do occur infrequently.

There's one lingering problem in the rotary screw air compressor world, and that's the use of automatic transmission fluid as an air compressor lubricant. This is done less and less, but the results can be even more catastrophic. We know of one plant that used ATF, and the check valve on the separator failed, spraying ATF into the back of the starter panel. This caused a small fire.

§ 56.13019 Pressure system repairs

Repairs involving the pressure system of compressors, receivers, or compressed-air-powered equipment shall not be attempted until the pressure has been bled off.

This is also self-evident.

§ 56.13020 Use of compressed air

At no time shall compressed air be directed toward a person. When compressed air is used, all necessary precautions shall be taken to protect persons from injury.

The obvious case for this is workers using compressed air to blow off dirt or dust on

their person. This practice was common and is getting less so, but it's still prevalent enough that it's problematic. The eyes are vulnerable to compressed air-driven particulate, but concern also exists for the skin, as well. There are quite a few gory pictures of hand injuries some cement plants use to emphasize the importance of not directing the air towards the skin. Compressed air should never be directed at a person.

A second common but often unrecognized problem is the hazard created by a piece of equipment's exhaust. Air cannon discharges often create a hazard because of their peculiar geometry and how they are often mounted.

This article is dedicated to the memory of Bruce Sellers, Palmetto State Training, who did all he could to keep us safe in mine sites. His enthusiasm and dedication to safety allowed us to share concerns with customers, making their operations safer. Special thanks go out to Brian Sellers, Bruce's son, and Daryl Hollnagel, CAC's corporate attorney, for reviewing this document. **BP**

About Paul Edwards

Edwards started with Ingersoll Rand in 1982 and worked in various field and office positions. He opened Compressed Air Consultants in 2003 as an independent audit organization with the tagline "It's about money, not air." Living up to that standard means the company's advice often differs from traditional approaches, but the goal is to drive operating costs down and productivity up while spending as little capital as possible.



About Compressed Air Consultants

Compressed Air Consultants is an independent, 20-year-old auditing firm. It specializes in creating ROI projects through demand-side analysis and improved use of existing assets. In most of its audits, gains can be realized without purchasing new air compressors. Its three principles (two in the United States and one in Europe) have 100 years of combined compressed air experience. Visit <https://www.loweraircost.com>.

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Refrigerant Regulations Reshape Chiller Thermal Performance Engineering

By Paul Johnson, Director of Technology and R&D, G&D Chillers

► For decades, specifying a glycol chiller was primarily a thermal engineering exercise. You defined your process temperature, calculated your heat load, selected your refrigeration compressor technology and sized your heat exchangers. The refrigerant was almost an afterthought – choose R-404A or R-448A, load it and move on.

Now, there's an entirely new process and a new set of standards guiding the process cooling industry. Three overlapping regulatory frameworks are as important to chiller design as the vapor-compression cycle itself:

1. The EPA's AIM Act, which phases down high-GWP HFCs
2. Updated ASHRAE Standards 15 and 34, which classify A2L refrigerants and define their safety requirements
3. The 2024 ICC I-Codes, which have updated building and mechanical codes to permit A2L use with specific engineering controls in place

This is not a future problem. The EPA phase-down rules affecting industrial process

Above: This chiller uses propane as a refrigerant and includes six refrigeration compressors.

cooling equipment took effect on January 1, 2026. If you are specifying new equipment or planning a replacement cycle, these standards are already in play.

We standardized our glycol chiller platform on A2L refrigerants – not because we had to, but because our customers need equipment that's not only compliant today but also serviceable for the next 20 years. The decision required working through the engineering implications of these three frameworks at the same time. This article documents what we learned and, hopefully, sheds light on where the industry is headed.

Breaking Down the New Chiller Regulations for Engineers

Understanding the refrigerant transition requires working through these three regulatory frameworks simultaneously. Each governs a different aspect of the system. Compliance with one does not guarantee compliance with the others.

The EPA AIM Act: Refrigerants Permissible for New Equipment. The American Innovation and Manufacturing (AIM) Act authorizes the EPA to phase down the production and import of hydrofluorocarbons (HFCs). The mechanism is a tiered phase-down

schedule reducing how much HFC refrigerant can be manufactured or imported into the U.S. over time, eventually capping production at 15% of the 2011-2013 baseline by the year 2036.

For industrial process cooling applications, the rule is specific. As of January 1, 2026, new chillers serving industrial process cooling systems with setpoints above -22°F (-30°C) must use refrigerants with a GWP of 700 or lower. This eliminates most of the legacy HFC blends that have dominated glycol chilling applications for the past three decades.

R-404A has a GWP of 3,922. Many R-448A blends fall around 1,390. Neither can be specified for new industrial process cooling equipment. This is not a grandfather clause situation for new equipment. If



This air-cooled chiller is standardized on A2L refrigerants across commercial applications

Refrigerant GWP Comparison			
Refrigerant	GWP	Classification	Status
R-404A	3,922	A1 (non-flammable)	Eliminated for new industrial process cooling equipment
R-448A	~1,390	A1 (non-flammable)	Eliminated for new industrial process cooling equipment
R-454B (Opteon XL41)	~466	A2L (mildly flammable)	Compliant; used in HVAC and process cooling
R-32	675	A2L (mildly flammable)	Compliant; higher-pressure applications
R-290 (propane)	3	A3 (flammable)	Ultra-low GWP; requires hazardous-location engineering

you're buying a new glycol chiller today, it cannot be built with these refrigerants for industrial process cooling applications. Any glycol chiller specified today for an industrial process cooling application must use a refrigerant with a GWP at or below 700 – no transitional provisions apply to new equipment.

ASHRAE Standards 15 and 34: The Safety Architecture. ASHRAE 34 is the refrigerant safety classification standard. It uses a two-part designation: The first letter indicates toxicity (A for lower, B for higher), and the number indicates flammability (1 for non-flammable, 2L for mildly flammable with burning velocity at or below 10 cm/s, 2 for flammable, 3 for highly flammable).

A2L is the new critical category. These refrigerants have low toxicity and mild flammability – a burning velocity at or below 10 cm/s, compared to propane's 46 cm/s. They can be used in occupied commercial and industrial spaces with defined engineering controls. That distinction – that mild flammability does not require the same engineering response as high flammability – is what makes A2Ls practical for packaged commercial chillers.

ASHRAE 15 is the system safety standard. It defines refrigerant concentration limits (RCL) by occupancy category, ventilation requirements, leak detection specifications and machinery room design criteria. The RCL limits are a binding design constraint: They determine maximum permissible refrigerant charge, which in turn drives component selection, circuit architecture and piping design.

ICC 2024 I-Codes: Code Adoption and Permitting. The 2024 International Mechanical Code and International Fire Code formally permit A2L refrigerants with defined engineering requirements. This is a

meaningful change: Earlier code editions were more restrictive about any refrigerant with a flammability classification.

However, there is a catch: State and municipal adoption of the 2024 I-Codes is uneven. Some jurisdictions are current; others still operate under 2018 or 2021 editions. Before specifying A2L equipment for a given project, engineers need to verify which code edition is in force for that jurisdiction and be prepared to work with the authority having jurisdiction (AHJ) on A2L system approvals where older editions still apply.

These three frameworks – EPA AIM Act, ASHRAE 15/34 and the ICC I-Codes – must be read together. Refrigerant selection, system safety engineering and installation code compliance all affect each other. Engineers who understand each framework independently and holistically will specify equipment correctly the first time – a critical step saving time and money down the road.

What A2L Means for Thermal Performance

One of the most common concerns I hear from engineers encountering A2L refrigerants for the first time is about performance and whether or not capacity will suffer. Will the system deliver the same cooling capacity? Will efficiency suffer?

The short answer to that last question is no. The vapor-compression cycle is the same. A2L refrigerants operate within familiar pressure and temperature ranges, with thermodynamic properties delivering efficiency comparable to – and in many cases modestly better than – the HFC refrigerants they replace.

The efficiency story for A2Ls in glycol chilling applications – 20°F to 50°F (-7°C to 10°C) leaving fluid temperature – is largely positive. At these temperature ranges, A2Ls maintain strong



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COP performance. The concern about degraded thermal performance has not materialized in practice.

What does change is the engineering required around the refrigerant's safety classification. A2Ls are mildly flammable. That property drives requirements around refrigerant charge limits, enclosure design, leak detection, ventilation and electrical component ratings. None of these requirements is prohibitive. But they must be designed in from the start; they cannot be field-retrofitted onto a conventional HFC chiller.

The distinction between A2L and A3 refrigerants matters here. R-290 (propane) carries a higher flammability classification than A2Ls and requires more rigorous hazardous-location engineering, including Class I, Division 2-rated fans and ducted enclosure ventilation. The trade-off is a GWP of approximately 3, essentially zero environmental impact from refrigerant leakage. The right refrigerant depends on the application, facility layout and local code adoption, but both A2L and R-290 pathways are viable for commercial glycol chilling.

Charge-Limit Engineering: Where the Real Work Lives

If there is one discipline most clearly differentiating A2L-compliant chiller design from conventional HFC design, it is refrigerant charge-limit engineering. This is where regulatory requirements translate directly into hardware decisions.

The governing framework is the ASHRAE 34 refrigerant concentration limit (RCL). For a given occupancy category, the RCL defines the maximum refrigerant concentration in the space in a worst-case total release scenario. For commercial and industrial process cooling applications, the RCL is a hard ceiling. Engineers must design to it, not around it.

The practical implication: A chiller cannot simply be recharged with a lower-GWP refrigerant and called compliant. The charge quantity itself must be appropriate for the installation environment. For larger packaged chillers in particular, this requires rethinking the system architecture from the ground up.

Four Engineering Levers for Charge Reduction

Heat Exchanger Selection. Braze plate heat exchangers hold dramatically less refrigerant than shell-and-tube designs at equivalent capacity – in many cases 50 to 70% less. Switching from shell-and-tube to braze plate evaporators is typically the single most impactful charge-reduction measure available. Microchannel coils offer similar advantages on the condenser side. The thermal performance of braze plate exchangers in glycol chilling applications is excellent; the charge reduction benefit is essentially free.

Circuit Architecture. Dual-circuit and multi-circuit designs allow each refrigerant circuit to be sized – and

charged – independently. The total system capacity is maintained, but each circuit's charge stays within RCL limits. There is an additional efficiency benefit: Multi-circuit systems improve part-load performance by staging refrigerant compressors to match actual load rather than running a single large refrigerant compressor at reduced efficiency. For applications with variable load profiles – wineries, food processing, data centers – this is a meaningful operational advantage.

Piping Discipline. Minimizing the length of liquid and suction lines, optimizing pipe diameters to reduce dead volume and routing refrigerant piping carefully are unglamorous but measurable contributions to charge reduction. This is detail work. On a large system, it adds up. Routing decisions made during initial layout lock in refrigerant charge requirements for the life of the equipment.

Liquid Receiver Minimization. The liquid receiver is often a significant source of refrigerant volume. Reducing or eliminating it requires tighter electronic expansion valve (EEV) tuning and more precise control logic, but enables meaningful charge reduction without sacrificing system stability. This approach demands more from the control system but pays dividends in system responsiveness and efficiency.

A Real Number to Illustrate the Scope

When we developed our Elite 290 series – our R-290 (propane) platform – the charge-reduction challenge was severe. Propane carries an A3 flammability classification, so charge requirements are more stringent than for A2Ls. Starting from a conventional dual-circuit design carrying approximately 95 pounds of refrigerant per circuit, we worked through each of these levers: braze plate evaporators, optimized piping, EEV tuning and receiver minimization.

The final design landed at six pounds of propane per circuit – a 16-to-1 reduction – while delivering full rated capacity at the design setpoint. For context, that is less refrigerant by weight than a standard backyard barbecue cylinder contains.



This chiller uses propane as a refrigerant with near-zero global warming potential and is designed to be future-proof, exempt from HFC phase-out programs. Each chiller contains semi-hermetic refrigeration compressors partnered with an oversized air-cooled condenser.

The charge-reduction engineering developed for R-290 has carried directly into our A2L platform design. The principles are the same even if the thresholds are different. Reduced charge improves system response, tightens superheat control and reduces risk, outcomes that matter regardless of which refrigerant is in the system.

Safety Engineering: Four Elements to Consider in the Design Phase

A2L compliance is not a single checkbox. It is a set of integrated engineering requirements that must be built into the system

design from the outset. These elements must be engineered in; retrofitting them in the field is not a viable path.

Integrated Leak Detection. Refrigerant sensors must be positioned at appropriate accumulation points based on the refrigerant's vapor density relative to air. For most A2Ls, which are heavier than air, sensors belong low in the equipment enclosure. Alarm thresholds are typically set at 10% of the lower flammability limit (LFL), a conservative margin providing substantial time between alarm and any flammability risk.

A chiller cannot simply be recharged with a lower-GWP refrigerant and called compliant. The charge quantity itself must be appropriate for the installation environment. For larger packaged chillers in particular, this requires rethinking the system architecture from the ground up.

At alarm, the system should de-energize the chiller and activate ventilation. This logic must be integrated into the chiller's control system, not added externally, and it must be documented and verified during commissioning. A leak detection sensor mounted to the skid without integration into the control sequence does not satisfy ASHRAE 15 requirements.

Ventilation Strategy. ASHRAE 15 ventilation requirements are calculated from refrigerant charge, room volume and occupancy classification. For outdoor or semi-outdoor installations – which describe a large share of commercial and industrial process cooling – the natural ventilation of the installation environment typically satisfies ASHRAE 15 requirements. For indoor installations, mechanical ventilation sized to the RCL calculation is required.

Ventilation design must be coordinated between the chiller manufacturer and the installing engineer before the project reaches startup. It cannot be resolved at commissioning.

Electrical Component Ratings. Components inside A2L refrigerant enclosures must be rated for use in mildly flammable atmospheres. Updated UL and ETL standards now address A2L-compatible component certification. This means attention to spark suppression, motor winding insulation class and control panel wiring practices. For A3 systems (R-290), the requirement escalates to Class I, Division 1 ratings – a more involved specification with a smaller field of certified components.

Safety Interlock Documentation. A2L installations increasingly require AHJ review, particularly in jurisdictions still adopting updated I-Codes. The equipment's technical file must document the leak detection alarm logic, ventilation activation sequence, safe shutdown procedure and component certifications. Chiller manufacturers should provide this documentation as a standard deliverable. Engineers should request it during the submittal stage – not discover it's missing during inspection.

The integration of these four elements is what distinguishes a chiller that's technically A2L-compatible from one that's genuinely A2L-compliant. They are not the same thing.

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Waterbrook Winery/Precept Wine

Waterbrook Winery, located just outside downtown Walla Walla, WA, has been one of the anchor estates of the Walla Walla Valley appellation since the early days of the region's emergence as a world-class wine area. Today, it operates as a flagship brand within Precept Wine, a Seattle-based company managing over 30 wine labels and a substantial production and distribution infrastructure across the Pacific Northwest.



A six refrigeration compressor, propane refrigerant chiller with an oversized air-cooled condenser installed at Waterbrook Winery.

When Waterbrook's operations team began evaluating chiller options for their cooling system, the conversation moved past refrigerant type to refrigerant strategy quickly. Like many commercial operations in agriculture and food processing, Waterbrook was looking at a longer planning horizon than a single equipment cycle. The question was not only what would work today, but what would still be the right decision in 10 to 15 years.

The answer was a chiller with a GWP of approximately 3, exceeding the EPA's 700 GWP threshold not by a margin, but by a factor. For Precept Wine, whose portfolio spans more than 30 labels and whose decisions propagate across a large production infrastructure, choosing equipment sitting well ahead of the regulatory curve matters for future-proofing its large-scale operations.

For a winery, precise temperature control isn't a preference – it's a production requirement. Fermentation temperature management

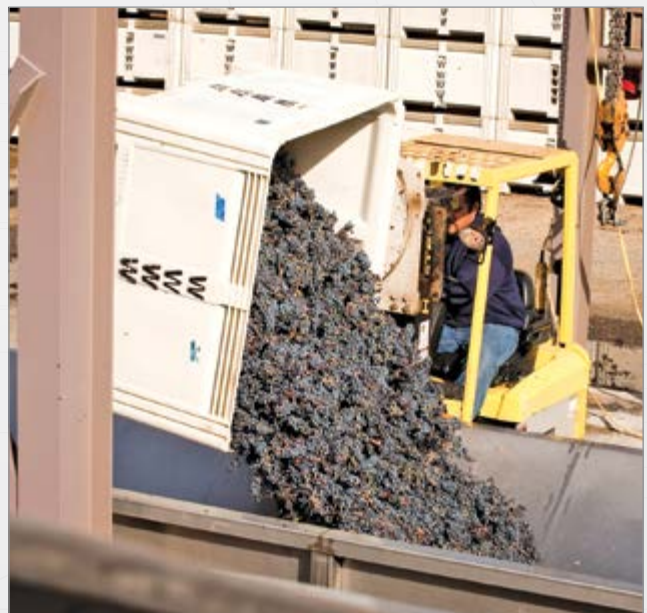
is one of the most consequential variables in wine quality. Glycol chilling systems that drift, cycle erratically or go down during peak fermentation season create quality and financial risk winemakers take seriously.

The specified chiller delivers on both fronts. The winery's unit achieved a 22-to-1 refrigerant charge reduction versus a conventional system and also produced tighter superheat control, more responsive load following and consistent capacity at the design setpoint. These qualities translate to fermentation temperature stability.

From a compliance standpoint, the installation gives Waterbrook – and, by extension, Precept Wine's portfolio planning – a clear forward position. R-290 is a natural refrigerant predating the HFC era. Whatever the regulatory trajectory looks like over the next 20 years, this chiller isn't at risk of becoming noncompliant.

This installation is one of a growing number of food and beverage projects moving to ultra-low-GWP refrigerants ahead of regulatory requirements. The calculus is straightforward: The engineering investment to comply today is no greater than the engineering investment to comply in three years, and the equipment purchased today has a 15- to 20-year life. Getting that decision right matters.

"We wanted a decision we wouldn't have to revisit in five years. The Elite 290 gave us that, and G&D made the whole process easy," said Mike Allen, Director of Facilities, Precept Wine.



Wine production at Waterbrook Winery outside Walla Walla, WA.

Validating Thermal Performance: What the Specifications Actually Mean

Understanding how to evaluate chiller performance data matters more as refrigerants change and new products enter the market. Rating standards describe a specific set of conditions that rarely match what happens in the field.

AHRI 550/590. Air-cooled glycol process chillers are rated under AHRI 550/590. These standards define entering and leaving fluid temperatures, ambient temperature and glycol concentration at the rating condition. Published capacity and efficiency data are valid at those conditions, and often nowhere else.

At ambient temperatures above 95°F (35°C), air-cooled chiller capacity can derate by 15 to 25% compared to published ratings, depending on condenser design and control strategy. For facilities in hot climates or with equipment located in warm enclosures, this derating is not academic. A chiller selected at AHRI-rated capacity may be undersized for peak summer demand in a hot climate.

The Correct Specification Inputs. Before evaluating submitted performance data, engineers should specify leaving fluid temperature (LFT) at design load, entering fluid temperature (EFT), design flow rate, glycol type and concentration and design ambient temperature. Then verify the manufacturer's submittal data reflects performance at those exact conditions, not AHRI standard conditions.

A chiller rated at 50 tons at 45°F (7°C) LFT may deliver only 38 tons at 28°F (-2°C) LFT under the same ambient conditions. LFT is the number that matters for your process, not the nameplate tonnage.

COP Versus IPLV. Coefficient of performance (COP) at full design load is the right metric for steady-load applications, such as dairy and food processing. Integrated part-load value (IPLV) is more informative for applications with variable loads, such as HVAC, where cooling demand tracks environmental and seasonal conditions. Multi-circuit chillers improve IPLV by staging refrigerant compressors rather than throttling a single large machine.

Our chillers ship after a factory run-test under load that validates capacity at specified

conditions, confirms refrigerant circuit integrity, exercises safety interlock logic and verifies control setpoints. Engineers should request the factory test report as part of the submittal review. It's the most direct confirmation the equipment will perform as specified.

Planning the Transition: A Practical Framework

The regulatory clock isn't pausing. The HFC phase-down accelerates through 2036, and refrigerant pricing for legacy HFCs is already reflecting tightening supply. Operators who begin evaluating their chiller fleets will now have better options – and lower transition costs – than those who wait.

A few questions worth working through for any commercial or industrial process cooling fleet:

- What refrigerant does each chiller in your facility use, and what is its GWP? Which systems are above the 700 GWP threshold that now applies to new industrial process cooling equipment?
- When does each unit come up for replacement? Is there a planning window to align refrigerant compliance with normal equipment lifecycle decisions?
- What code edition is in force in your jurisdiction? The difference between the 2021 and 2024 ICC I-Code editions has material implications for A2L system permitting.
- Does your chiller manufacturer offer factory-tested A2L-compliant safety systems, long-term service infrastructure for the new refrigerant class and engineering support for applications where charge limits require system-level design decisions?

Different facilities will reach different answers on A2L versus R-290. But both paths are

engineered, tested and available. The era of treating refrigerant as an afterthought is over. The era of treating it as an engineering discipline has begun.

Thermal performance standards for glycol chillers are no longer solely about heat-transfer efficiency. They are about refrigerant compliance, safety engineering, charge-limit architecture and installation code navigation, all of which now belong to the same design problem.

The engineers who understand ASHRAE 15 and 34, the AIM Act phase-down schedule and the 2024 I-Code framework today will specify equipment that performs, installs without permitting surprises and remains serviceable for the next 20 years. The refrigerant transition is not a disruption to standard chiller engineering practice; it's the next chapter. **BP**

About the Author

Paul Johnson is Director of Technology and R&D at G&D Chillers, where he has served as Chief Engineer since 2006, leading design, testing and continuous improvement across the company's industrial and process chiller platforms. Over two decades, he has driven the shift toward higher-efficiency refrigeration compressors, low-GWP refrigerant adoption and rigorous factory testing, now backed by the engineering resources of a global industrial technology leader. He's based at G&D's Junction City, OR, facility.



About G&D Chillers

G&D Chillers, an Ingersoll Rand business based in Junction City, OR, has standardized its glycol chilling platform on low-GWP A2L refrigerants – including R290 propane units – for commercial brewing, wine, dairy, food processing, manufacturing, biogas, data centers and commercial HVAC applications. Since 1993, the company has supported industry leaders including Ninkasi, New Belgium Brewing, Willamette Valley Vineyards, Jim Beam, Boeing and Diageo. For more information, visit <https://gdchillers.com>.

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Cooling Tower Gearbox Standards

By Daniel Rosseljong, Senior Product Manager, Sumitomo Drive Technologies

How AGMA, CTI and ISO guidance help specify reliable severe-duty drives for industrial process cooling.

► Cooling towers are central to process cooling in power generation, chemical processing, metals, water infrastructure and other heat-intensive operations. Their fan drives operate in difficult conditions, often high above grade, exposed to moisture, heat, vibration and limited maintenance access. At the center of that mechanical system is the gear speed reducer.

A gearbox selection cannot be reduced to horsepower, ratio and a catalog service factor. Long-term performance depends on how the reducer, fan, motor, support structure, lubrication system and maintenance plan work together. Industry standards provide engineering baselines. The most reliable installations use that baseline to make disciplined application-specific decisions.

Why a Gearbox Standards Framework Matters

Standards are the starting point for evaluating the mechanical integrity of a cooling tower gearbox. They establish recognized methods for rating gear teeth, sizing shafts, evaluating bearings, selecting lubrication and testing the completed drive. Those common methods give owners, OEMs, consultants and gearbox manufacturers a shared technical language.

That foundation matters because cooling tower service is rarely gentle. Many units operate for long annual hours. Fan loads can

Above: A multistage horizontal gearbox installed in a cooling tower

fluctuate with wind, seasonal temperature changes and operating demand. The equipment may see repeated starts and stops, thermal cycling, corrosive airborne contaminants and water exposure. When a drive failure stops a process-critical fan, the consequence can extend well beyond the gearbox repair itself.

A service factor is useful because it creates a consistent way to account for application severity. It's not a substitute for a complete system review.

For that reason, minimum compliance is not the same as lifecycle reliability. A robust specification treats standards as the floor, then applies additional design margin, environmental protection and maintenance access based on the realities of the site.

The central design question is does the drive only meet a published rating, or is it designed for the actual fan inertia, structural behavior, exposure, starting profile and maintenance practices of this tower? The second question is the one protecting uptime.

The Standards Shaping Cooling Tower Gearbox Design

No single document covers every aspect of an industrial cooling tower drive. The

specification usually combines gear-rating standards, enclosed-drive component standards, cooling-tower guidance and vibration standards. Together, they create a disciplined framework for evaluating a complete drive system.

Start with the Mechanical Rating

The ANSI/AGMA gear-rating standards provide the underlying method for evaluating the gear teeth transmitting fan torque. The core calculations consider bending fatigue strength, surface durability or pitting resistance, load distribution and other factors influencing gear life. In a cooling tower drive, these calculations should reflect more than a stable nameplate load.

Startup torque, fan inertia, changing aerodynamic loads, temperature and the expected condition of the lubricant over time can all influence the real duty imposed on the gearset. A conservative design process considers these variables early, rather than assuming ideal operating conditions throughout the service life of the unit.

The component standards for enclosed gear drives extend the discussion beyond the teeth. Shafts, keys, fasteners, bearings, housing rigidity, oil seals, breathers and monitoring provisions each shape reliability. A technically sound gearset can still perform poorly when shaft deflection, housing movement, inadequate bearing support or compromised sealing changes the alignment and lubrication conditions around it.

Standard Family	Primary Focus	Cooling Tower Implication
ANSI/AGMA 2001/2101 and 2003	Gear tooth bending strength, surface durability and load factors	Establishes the core gear-rating method for helical and bevel stages
ANSI/AGMA 6001/6101	Shafts, keys, fasteners, housings, bearings and supporting components	Helps evaluate load paths, stiffness and components beyond the gear mesh
ANSI/AGMA 6013/6113	General industrial enclosed gear-drive design and service classifications	Provides the system-level reference point for an enclosed gear drive
ANSI/AGMA 9005	Lubricant selection and lubrication practice	Supports oil selection, water management and maintainability
CTI STD-111 and STD-167	Cooling-tower and air-cooled-condenser gear speed reducer guidance	Addresses fan-drive service, vertical arrangements and severe operating environments
CTI STD-163; ISO 20816; ISO 14694	System and machine vibration evaluation	Supports baseline acceptance testing and investigation of operating vibration
CTI ESG-138	Long-term cooling tower storage guidance	Helps plan protection for seasonal shutdowns and extended idle periods

Table 1. Standards commonly referenced during the design and specification of industrial cooling tower fan drives. Confirm the current edition and contract applicability for each project.

ANSI/AGMA 6013/6113 brings those elements together as a system-level industrial gear-drive framework. It also provides application service classifications. For large industrial cooling tower fan drives, the application must be reviewed carefully because generic fan categories may not capture the inertia, duty cycle, environmental exposure or maintenance limitations of a severe-duty tower.

Service Factor Is a Starting Point, Not the Final Answer

A service factor is useful because it creates a consistent way to account for application severity. It's not a substitute for a complete system review. In cooling tower service, the motor rating, fan inertia, start and stop frequency, aerodynamic load, tower stiffness and operating schedule all affect the loading a gearbox must tolerate.



Detailed view of an industrial gearbox showing key lubrication, ventilation, grounding and safety components.

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>> Cooling Tower Gearbox Standards

CTI guidance is especially important here because it focuses on the cooling tower environment. The draft framework for industrial water cooling tower gear reducers calls for a minimum 2.0 service factor relative to motor power. That target is more conservative than many general industrial fan assumptions and recognizes the long operating hours and high consequence of failure in large tower installations.

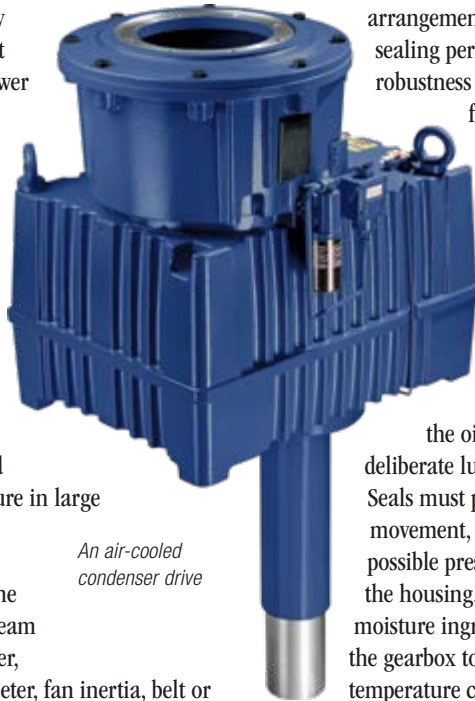
The key is to document the actual duty. The project team should define motor power, reduction ratio, fan diameter, fan inertia, belt or direct-drive arrangement, fan radial and thrust loads, frequency of starts, operating speed range, wind exposure, structural mounting details and maintenance expectations. A gearbox supplier can only design for the loads identified.

A useful specification principle is to specify the system inputs creating load, not only the gearbox output requirements. The supplier needs the fan inertia, thrust and radial loads, structure details and operating profile to evaluate the complete drivetrain.

CTI Guidance Brings the Tower Environment into Focus

Cooling towers create an environment different from most catalog gear drive applications. The reducer may be mounted vertically. It may be exposed to humid air, water droplets, biological contaminants, direct sunlight and seasonal temperature swings. The fan can impose substantial radial and thrust loads. Access may be constrained by elevation and cooling tower geometry.

CTI STD-111 for industrial water cooling towers and CTI STD-167 for air-cooled condensers translate those environmental and mechanical realities into guidance for gear speed reducers. The intent is clear: The drive should be purpose-designed for the application. A multi-purpose reducer fitting the speed and torque on paper may not provide the bearing



An air-cooled
condenser drive

arrangement, lubrication control, sealing performance or structural robustness needed for a large fan application.

Vertical operation deserves specific attention. Gear and bearing lubrication must reach all critical elements despite orientation.

Bearings above the oil sump may need a deliberate lubrication method. Seals must perform under shaft movement, weather exposure and possible pressure changes within the housing. Breathers must limit moisture ingress while allowing the gearbox to equalize pressure as temperature changes.

Lubrication and Sealing Are Reliability Systems

Lubrication is not a maintenance afterthought; it is part of the gearbox design. ANSI/AGMA 9005 provides guidance on industrial gear lubricant selection and practice. For cooling tower service, the lubricant must also support real environmental conditions, including high operating temperatures, water exposure, long drain intervals and the possibility of extended idle periods.

Oil with strong water-separation performance can help operators identify and remove contamination before it degrades the lubricant film. Oxidation resistance supports long service intervals in elevated-temperature service. A sump heater can improve low-temperature startup behavior and may help support a practical year-round viscosity strategy, depending on the operating conditions and manufacturer recommendations.

The best lubrication strategy also makes good maintenance easier. Sight glasses, accessible fill and drain points, sampling ports, filtration provisions and clear inspection practices are not convenience features. They reduce the chance a difficult access condition becomes a missed maintenance task. In a tower where access is limited, monitoring and maintainability should be designed into the drive.

Vibration Must Be Evaluated as a System

CTI STD-163 establishes vibration limits and measurement practices for new water cooling towers. It addresses measurement locations, methods and acceptable mechanical vibration levels for the cooling tower system. It's valuable as a new cooling tower baseline and as a reference point when troubleshooting vibration in operating equipment.

The vibration question does not end with the gearbox. A tower can transmit vibration into the drive through the structure. Fan imbalance, misalignment, mounting deflection, resonant conditions and aerodynamic instability can add loads that aren't visible in a simple gear-rating calculation. ISO 20816 focuses on vibration produced by the machine itself, while ISO 14694 provides industrial fan-related vibration guidance. These documents are useful, but they do not replace a full review of torsional behavior in a high-inertia fan system.

The best lubrication strategy also makes good maintenance easier. Sight glasses, accessible fill and drain points, sampling ports, filtration provisions and clear inspection practices are not convenience features. They reduce the chance a difficult access condition becomes a missed maintenance task.

When cooling towers use variable-frequency drives (VFDs), the review should include the full intended speed range. VFDs can reduce electrical and mechanical stress through controlled acceleration. They can also help match fan speed to cooling demand. However, the operating range must avoid structural or drivetrain resonances, and the gearbox must be evaluated for the actual speed and torque conditions it will see.

Design for the Difference Between a Rating and Real Operation

The central weakness in a lowest-first-cost selection is it often assumes the field will behave like the calculation. In practice, cooling tower structures flex. Fans start and stop. Oil becomes

contaminated. Maintenance windows narrow. A seal working in a clean indoor test environment may be challenged by moisture, heat, vibration and shaft movement on top of a tower.

A resilient cooling tower gearbox specification acknowledges those conditions. It requires a rigid housing and load path to support gear alignment. It accounts for fan radial and thrust loads at the bearing arrangement. It specifies a sealing and breather approach appropriate for the orientation and exposure. It confirms lubrication of all bearings and gear meshes. It identifies the vibration acceptance plan and the maintenance access required after startup.

The result may increase first cost. It can also lower total cost of ownership by reducing unexpected downtime, repair scope, oil-change difficulty and premature component wear. The decision should be made at the system level, not by comparing gearbox purchase price alone.

Common Failure Drivers and What to Do About Them

Gearbox failures usually develop from several manageable conditions rather than one dramatic design mistake. The following matrix can help teams connect common failure drivers with early symptoms, monitoring tools and preventive actions.

Failure Driver	Likely Symptoms	Monitoring Method	Preventive Action
Water ingress	Milky oil, corrosion, rising bearing or gear wear	Oil analysis, visual inspection, moisture checks	Use suitable seals and breather; inspect regularly; correct leakage paths
Contamination	Abrasive wear, elevated temperatures, reduced lubricant life	Oil analysis, particle counts, filter inspection	Use clean fill practices, filtration and planned oil sampling
Misalignment or structural deflection	Uneven wear, vibration, leakage, bearing distress	Vibration trend data, alignment checks, structural inspection	Verify mounting stiffness, load paths and coupling/fan alignment
Heat	Oil oxidation, elevated temperature, seal hardening, reduced life	Temperature trends, oil condition, infrared checks	Confirm thermal capacity, ventilation, lubricant and oil level
Starts, stops and unstable fan loading	Shock loading, cyclic stress, torsional effects, damage over time	Review operating data, VFD parameters and vibration trends	Document fan inertia; use controlled starts; avoid resonant speeds
Poor access or deferred maintenance	Missed inspections, low oil level, late failure detection	Maintenance records, inspection routes, remote condition data	Design accessible service points and clear preventive-maintenance tasks

Table 2. Common failure drivers are interconnected and should be addressed in both the initial specification and the maintenance plan.

A Practical Specification Checklist

A cooling tower gearbox specification should make responsibilities clear. It should identify which party provides the fan data, who confirms the support structure, who selects the lubricant, how vibration acceptance will be measured and who owns the ongoing inspection program. The following items form a practical baseline for the specification discussion.

- **Gear rating:** Require an AGMA-compliant rating method appropriate for the gear configuration and documented design duty.
- **Service factor and duty:** Identify the required service factor, motor power, fan inertia, starts and stops, operating hours, speed range and VFD use.
- **Loads and structure:** Provide fan radial and thrust loads, mounting arrangement, support stiffness information and expected alignment conditions.





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>> Cooling Tower Gearbox Standards

Reference Standards and Guidance

This list summarizes the standard families cited in this article. Teams should confirm current editions, project applicability and contractual requirements before finalizing a specification.

ANSI/AGMA 2001/2101: Involute spur and helical gear tooth rating methods.

ANSI/AGMA 2003: Bevel gear rating methods.

ANSI/AGMA 6001/6101: Design and selection of components for enclosed gear drives.

ANSI/AGMA 6013/6113: Industrial enclosed gear-drive design and application guidance.

ANSI/AGMA 9005: Industrial gear lubrication guidance.

Cooling Technology Institute (CTI) STD-111: Gear speed reducers for industrial water cooling towers.

Cooling Technology Institute (CTI) STD-167: Gear speed reducers for air-cooled condensers.

Cooling Technology Institute (CTI) STD-163: Vibration limits in water cooling towers.

Cooling Technology Institute (CTI) ESG-138: Long-term storage procedures for cooling towers.

ISO 20816: Mechanical vibration evaluation.

ISO 14694: Industrial fan vibration and balance guidance.

Building Reliability into the Specification

Cooling tower gearboxes operate at the intersection of mechanical design, environmental exposure and plant reliability. AGMA/MPMA, CTI and ISO guidance provide the standards framework. The strongest results come from using that framework to describe the real application with enough detail for the gearbox supplier to design and validate the full drive.

A reliable solution uses conservative mechanical design, purpose-built bearing and lubrication arrangements, robust sealing, practical inspection access and condition monitoring. It also recognizes that tower vibration, fan inertia, support structure behavior and maintenance practices can determine gearbox life as much as the published rating.

For owners, consultants and OEMs, the goal is straightforward: Specify the system for the life it must deliver, not only the load it must carry on day one. **BP**

About the Author

Daniel Rosseijong is Senior Product Manager at Sumitomo Drive Technologies, Sumitomo Machinery Corporation of America. He supports the application and development of industrial gear-drive solutions for demanding process and power-transmission applications.



About Sumitomo Machinery Corporation of America

Sumitomo Machinery Corporation of America operates throughout the Western Hemisphere under the global brand Sumitomo Drive Technologies. The organization supplies industrial power transmission and motion-control equipment to customers across North, Central and South America. Its work supports manufacturing, material handling, water treatment, mining, food processing, logistics, energy, metals and other industrial sectors.

- **Bearings and shafts:** Require bearing life and shaft/housing stress evaluation for actual fan loads, not only nominal torque.
- **Lubrication:** Define oil type or approved lubricant family, low-temperature strategy, water-management provisions, sampling access and drain/fill accessibility.
- **Sealing and breathers:** Specify protection appropriate for vertical orientation, humid service, contamination exposure and pressure changes.
- **Thermal performance:** Confirm the gearbox can reject heat at the expected ambient and operating conditions.
- **Vibration and commissioning:** Define baseline measurement locations, acceptance criteria and trend monitoring expectations.
- **Storage and shutdown:** Require a preservation plan for seasonal layup, extended outage and long-term storage.
- **Maintenance access:** Verify guards, lifting points, inspection access and safe work practices before the tower is commissioned.

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SALES ENGINEERING SKILLS

How Compressed Air Sales Engineers Close Sales in Uncertain Times

By Mark Allen Roberts, CEO, OTB Solutions



► Despite the importance of compressed air systems to manufacturing, many salespeople find buyers are taking longer to make decisions. The problem isn't that buyers suddenly stopped needing air compressors, compressed air dryers or service agreements. The problem is uncertainty.

Today's buyers are dealing with economic volatility, labor shortages, rising energy costs, tariffs, supply chain disruptions, margin pressure and growing pressure to justify capital expenditures. Even healthy companies are protecting cash and becoming more cautious about major purchases. Unfortunately, many compressed air sales engineers misdiagnose the problem. They assume hesitation means a buyer isn't interested. Most of the time, that's not true.

Sales engineers who consistently win in today's market aren't always the most technical. They're the ones who reduce risk, create clarity and help buyers make confident choices.

Decisions once involving a plant manager may now require approval from operations, finance, maintenance, procurement, engineering and executive leadership. I recently saw a \$160,000 air compressor project require approval from eight different stakeholders.

Every person at the table views the investment differently. Buyers evaluate much more than horsepower, cfm, pressure and efficiency. They evaluate risk. When buyers say, "We need to think about it," what they often mean is, "We're not fully convinced this is the safest decision."

The typical salesperson responds by offering discounts, increasing follow-up frequency or applying pressure. That usually makes things worse. The role of today's compressed air sales engineer isn't to pressure customers into buying; it's to help them make a smart business decision with confidence.

Stop Selling Air Compressors; Start Solving Problems

One of the biggest mistakes salespeople make is focusing exclusively on the cost of the new system. Great sales engineers help buyers understand the cost of waiting. Every month a customer delays, they may experience higher energy costs, increased maintenance expenses, lost production,

downtime risk, emergency repair costs, capacity constraints and reduced product quality. The key is credibility. Don't exaggerate numbers. Use actual plant data, leak studies, utility bills, pressure readings, maintenance records and production impacts. In uncertain times, buyers trust evidence more than enthusiasm.



Mark Allen Roberts will lead a Sales Engineering Workshop at the Best Practices 2026 EXPO & Conference in Indianapolis, IN. Visit <https://cabpexpo.com> to register.

Most buyers aren't afraid of spending money; they're afraid of making a mistake. That fear is amplified during uncertain economic conditions. Great sales engineers reduce perceived risk through evidence. They use case studies, customer references and site assessments. Trust isn't built by saying, "Trust me." Trust is built when buyers feel informed, understood and protected.

When projects stall, many salespeople disappear. I've coached some salespeople who stop following up because they don't want to report a lost sale and have their pipeline decrease. No wonder owners are

frustrated with sales pipelines full of quotes not turning into revenue! Others become relentless and annoying. Neither approach works.

Top-performing sales engineers deliver value. They share industry trends, energy-saving opportunities, maintenance recommendations, rebate programs, benchmarking information and optimization ideas. Their goal isn't to keep selling; their goal is to remain the trusted expert buyers think of first when they're ready to move forward. When uncertainty rises, trust becomes your greatest competitive advantage. **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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FACILITY MAINTENANCE

Gentex Develops Internal Compressed Air Standards to Meet Production Needs

By John Bilsky, Facilities Specialist, Gentex Corporation



► When I took over the compressed air systems for Gentex Corporation in January of 2004, the level of expectation was simple: If production had compressed air, then all was good. However, in a short time, it became evident internal compressed air system standards needed to be developed to support our fast-paced production facility. We developed four internal standards to better operate our compressed air system: measurements, reliability, data management and compressed air quality.

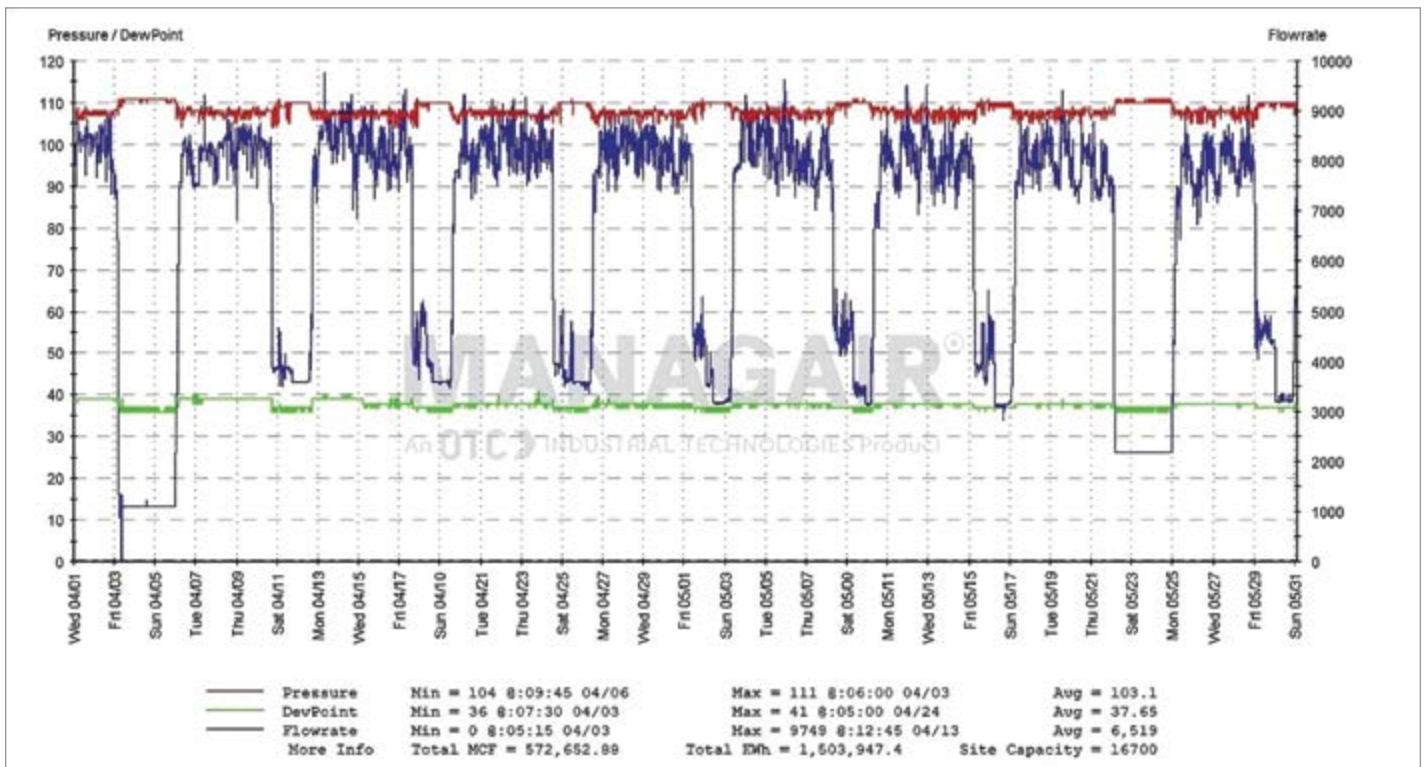
Measurements. We found three measurements crucial for a compressed air system. I call them “the Super Three”: pressure, flow and dew point. These are used to understand how our compressed air systems operate. To get a window on performance, we had to measure

the Super Three at different points in the compressed air system. We started by installing pressure gauges in the main header after the air compressors. Moving downstream, we added a pressure gauge to the wet (before the dryer) compressed air receiver tank. Finally, we installed pressure gauges after the prefilters but before the compressed air dryers.

We then installed pressure gauges after the compressed air dryers but before the oil-coalescing filters, as well as on the compressed air dry (after the dryer) receiver tank. Turning to production, we added pressure gauges in the main headers going to production, as well as to the production line feeds. We added pressure gauges to many of the compressed air drops to individual end-use points.

The second of the Super Three is compressed air flow. It was important to know whether or not our air compressors were making the specified flow and to see where this flow was being used. Flow meters also helped us understand whether or not we could support more growth. Just as with the pressure gauges, we installed flow meters in every main header after the compressed air dryers heading to production. Next, we installed them in each production line and to various end-use equipment. To ensure we never oversupplied the capacity of our compressed air dryers, wet tanks were sized smaller than dry tanks.

The third member of the Super Three is dew point. Without dew point monitoring, there’s no way to know whether or not compressed air dryers perform to specification. We placed dew



Monitoring the Super Three: pressure (red), compressed air flow (blue) and dew point (green)



Oil-free variable-speed centrifugal air compressors with magnetic bearings

point probes after every compressed air dryer and as a backup in every dry compressed air tank.

Today, after 20-plus years, the Super Three have evolved into the Super Four, with the addition of kilowatt monitoring for energy analysis.

Reliability. Another word for reliability at Gentex Corporation is redundancy. All production compressed air systems must be paired with a backup air compressor and a backup compressed air dryer. Thanks to that decision, our reliability is high. If you can find the budget and physical space, having redundant compressed air equipment is a plus.

Data Management. Our top priority is “Never shut down production!” To make sure we succeed, we take the initiative in collecting and analyzing real-time compressed air system data. All pressure gauges now include a digital display with a transmitter. All flow meters and dew point sensors are hard-wired into the data management system. All air compressors have kilowatt meters, and all air compressors and compressed air dryers have fault monitors. All condensate drains are hard-wired into the data management system to notify us immediately of a failure. We set alarms that page us for pressure, flow, dew point and equipment malfunctions. This enables us to see and troubleshoot problems before production has an issue. We analyze trended data often to maximize our success.

Compressed Air Quality. The types of compressed air processes used and the components selected determine compressed air quality for production. We select oil-free air compressors for circuit board production, for example, to reduce contaminants. That’s been

an internal standard since 2014. Since 2018, the compressed air for circuit boards has been 100% oil-free. Oil isn’t needed to operate our variable-speed drive centrifugal air compressors because they use magnetically controlled bearings. This technology reduces our carbon footprint, as well.

Our black piping contained rust from insufficient compressed air drying before my tenure, so we replaced it with welded stainless steel, Victaulic stainless steel, copper and aluminum piping.

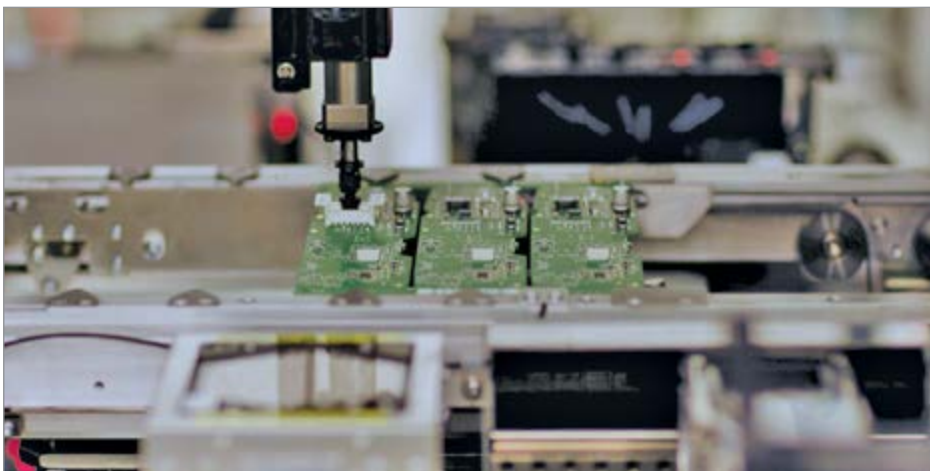
Correctly sizing compressed air filters also plays a role in maintaining compressed air quality, as does the frequency of maintenance. To ensure

filters perform as their specifications state, we send our compressed air to a third party for particle, water and oil analysis at a minimum of twice per year. We perform our own internal testing, as well. Lastly, the Super Three (now Super Four) must be in spec and delivered to production 100% of the time because we want production to always say we have excellent quality compressed air.

Twenty years ago, there were no flow meters, no dew point probes and only one or two pressure gauges in our compressed air system. Having a pressure gauge in the air compressor room didn’t help when end-use equipment on the production floor was faulting. I didn’t like waiting for production to call and notify me of problems. Internal standards for measurement, reliability, data management and compressed air quality were established so our company could supply dependable, high-quality, and worry-free compressed air meeting every production need. **BP**

About the Author

John Bilsky is the Facilities Specialist for compressed air, nitrogen and purified water at Gentex Corporation. He’s experienced in engineering design, engineering improvements and maintenance for compressed air, nitrogen and water purification systems supporting production, R&D and lab services. For more information, visit <https://www.linkedin.com/in/john-bilsky-24715b10/>.



Adding electronic components to a printed circuit board at Gentex Corporation.

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<https://us.kaeser.com/landingpages/events/bestpracticesexpo.aspx>

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Sotras

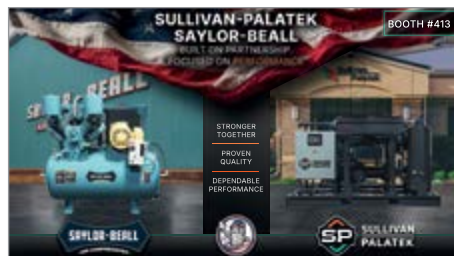
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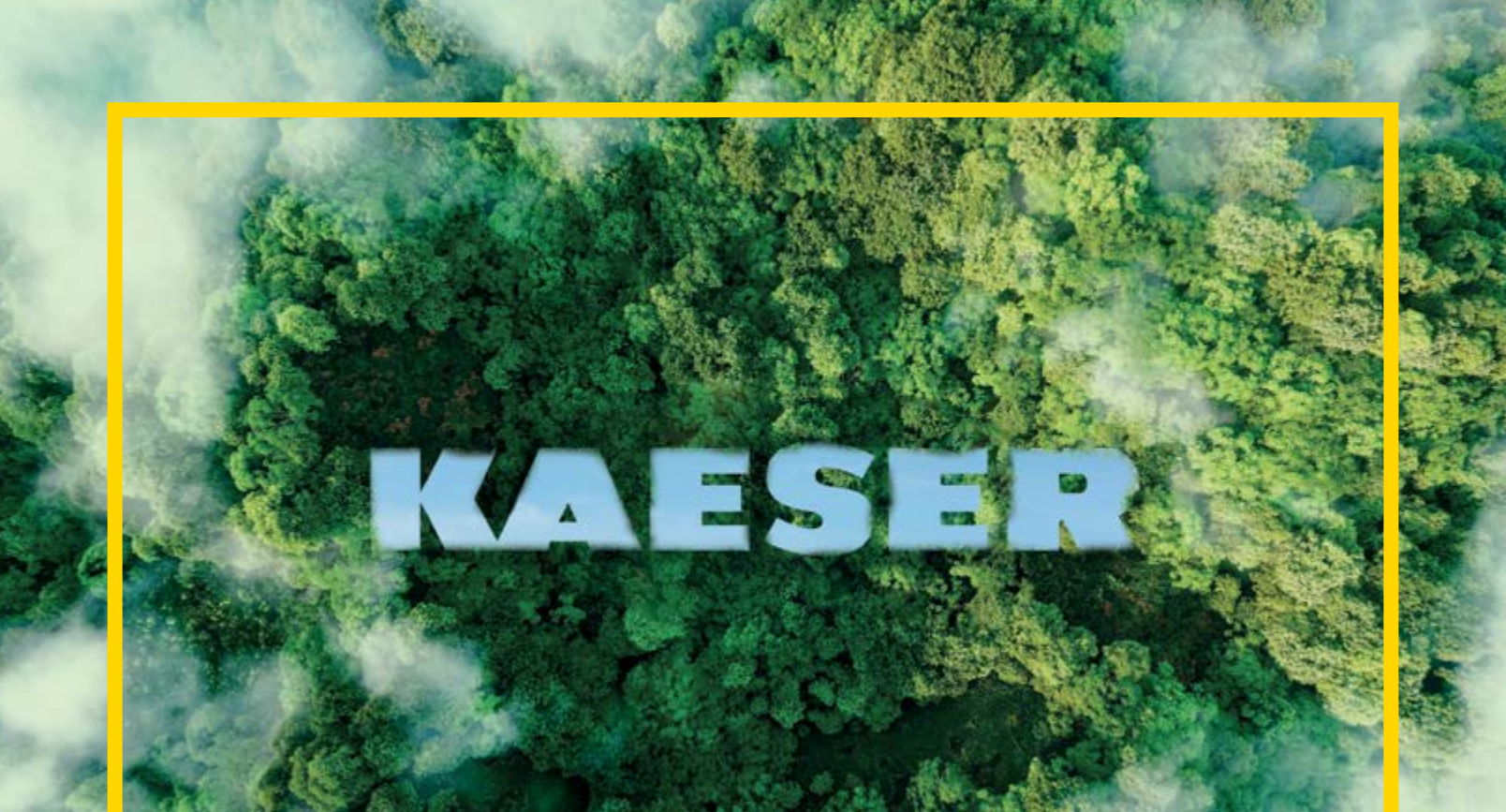
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